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Mississippians In Physics: Perspectives And Practice In A Search For Physics Excellence

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MISSISSIPPIANS AND PHYSICS: PERSPECTIVES AND PRACTICE IN A SEARCH FOR PHYSICS EXCELLENCE

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ABSTRACT

This mixed-method study represents a broad evaluation of the physics views of Mississippi physics students and physicists, along with an analysis of graduate school data, in a search for answers which might improve physics education in Mississippi. Descriptive statistics were calculated using data from eight graduate degree programs (from Fall 2003 through Full Summer 2012) at the University of Mississippi. This was done to find the percent of graduate degrees in each degree program which were awarded to in-state residents. It was found that of the eight University of Mississippi graduate degree programs in the study, two programs awarded a lower percentage of their graduate degrees to in-state residents than did the Physics graduate degree program. Also, data from graduate schools of five other U.S. universities from other states was compared with the data from the University of Mississippi graduate school. This was done in order to measure the percentage of physics graduate degrees which were awarded to in-state residents at each university. It was found that the University of Mississippi awarded a higher percentage of its physics graduate degrees to in-state residents than any of the other five universities in this study. Another part of this study was devoted to recording the physics views of physics students and physicists in Mississippi. Data was gathered via survey forms which measured the physics views of 16 physicists and 113 physics students. Descriptive statistics of the student and professor survey forms were used to

gather a broad description of physics views. The descriptive statistics portrayed evidence of possible weaknesses in physics self-efficacy within a sample of female physics lab students. The written responses of the students and professors were transcribed and categorized into themes. A total of 10 students and 17 physicists were interviewed, including 5 physicists who were categorized as native Mississippi physicists. The interviews were transcribed and categorized into broad themes. The physics views of Mississippi physicists and students were documented and recorded for future use by researchers or educators. Important historical documentation concerning Mississippi physics was gathered and recorded.

DEDICATION

This dissertation is dedicated, primarily, to my mother who spent a lifetime educating children and youth of all ages—most especially her own children. Secondarily, I would like to dedicate this dissertation to all of the rest of my family who suffered along with me as I had to focus on this work so attentively for so many years. Lastly, I would like to dedicate this dissertation to the poor, unknown scholar who struggles against the tide for the sake of righteousness and truth.

LIST OF ABBREVIATIONS

AL—Alabama

D.A.—Doctor of Art

LSU—Louisiana State University

M.A.—Master of Arts

M. Accy.—Master of Accountancy

MBA—Master of Business Administration

MN—Minnesota

M.S.—Master of Science

MS—Mississippi

NAEP—National Assessment of Educational Progress

NSF—National Science Foundation

OECD—Organization for Economic Cooperation and Development

PISA—Program for International Student Assessment

Ph.D.—Doctor of Philosophy

PhysTEC—Physics Teacher Education Coaltion

TIMSS—Trends in International Mathematics and Science Study

UM—University of Mississippi

UVA—University of Virginia

VA—Virginia

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CHAPTER 1: INTRODUCTION

Physics, like other natural sciences, plays an important role in the modern world. The discoveries of Einstein and other twentieth century scientists have raised physics to the pre-imminent position in science so that physics is now held to be the "ultimate science of matter" (Fuller, 2000, p. 99). Thus, if people desire to develop excellence in the sciences, they must develop competence in physics. However, when compared with the natives of other states and countries, many Mississippians have not yet achieved basic proficiency in science—much less competence in physics. According to *The Nation's Report Card* (U.S. Dept. of Ed., 2009), an online report published by the United States Department of Education (USDE), the 2009 National Assessment of Educational Progress (NAEP) science assessment scores of Mississippi eighth graders was the lowest of all 46 states (or jurisdictions) who participated in the study. The same report stated that only 15% of Mississippi 8th graders scored at or above the *Proficient* level on the NAEP science assessment; while in comparison, an average of 29% of students from the other states or jurisdictions scored at or above the *Proficient* level (U.S. Dept. of Ed., 2009).

A report, published by The National Center for Public Policy and Higher Education (2008), gave Mississippi a "D" grade on the *Preparation* index. The *Preparation* index, according to the online report (p. 2), was meant to measure "how adequately the state prepares students for education and training beyond high school." Only four other states scored a "D" or lower. The online report went on to state that Mississippi eighth graders "perform very poorly in math, science, reading, and writing" (p.3). These statistics lead one to conclude that Mississippi is producing a relatively small percentage of students who will be able to be successful in the higher level sciences—such as physics. The poor science performance of Mississippi eighth graders, as discussed in these reports, represents some of the first measurable signs of science underachievement by Mississippi students. And, there are also signs—at a higher level—that their general incompetence in science, which starts at a young age, may be discouraging Mississippians from pursuing advanced degrees in physics.

When this research project was first begun, the University of Mississippi was the only university in Mississippi that offered the doctoral degree in physics. Apparently, Mississippi State University has recently added a doctoral program in physics. But, at the time the researcher was designing this research study (in 2011 and 2012), the University of Mississippi was the only doctoral degree program for physics in the state, as far as the researcher was aware. And, during all the time the researcher worked as a graduate student in the physics department, there were very few native Mississippians who were graduate students in the physics department.

This was one of the things that first spurred the researcher to look into the question more deeply as a dissertation research project. Thus, the researcher, in seeking to justify the need for this study and in the process of writing a dissertation proposal, requested to review the graduation statistics from the graduate school at the University of Mississippi for the subject of physics (concerning the number of graduate degrees awarded to Mississippi residents versus non-Mississippi residents). After reviewing the statistics (which covered the time span from the fall semester of 2003 through the fall semester of 2011), only a relatively few native Mississippians were found to have received graduate degrees in physics.

And, the actual numbers of native Mississippians in the graduate school (for physics) are actually lower than the statistics show. This is true because some students who were actually born and educated in other states moved to Mississippi and only established "resident" status a relatively short time before being entered into the graduate school statistics as a Mississippi resident.

Since the Fall semester of 2003 up through the Full Summer semester of 2012, 15 Mississippians have received master's degrees in physics, and 7 Mississippians have received PhD degrees in physics from the University of Mississippi (see Figure 1). And, it is important to note that these "official numbers" also include any students who moved to Mississippi and gained a Mississippi residence status even though they were not necessarily born or educated in Mississippi. The researcher confirmed (via discussion with graduate students or former graduate students) that this was the case for some students.

The researcher obtained the "official numbers" (which show the number of graduate degrees awarded to Mississippi residents) by consulting the records provided to him by officials from the graduate school at the University of Mississippi. The available records concerning the residence of the graduate degree recipients did not go back further than Fall of 2003. Thus, the researcher was only able to analyze the records that spanned the time from the Fall semester of 2003 up through the Full Summer semester of 2012. But, during that nine-year time period, much information can be gleaned.

For example, from the Fall semester of 2003 up through the Full Summer semester of 2012, there were 35 total students who received master's degrees in physics and 18 students who received the PhD degree in physics at the University of Mississippi. Of the 35 master's degree students, only 15 listed Mississippi as their state of residence; of the 18 PhD students, only 7 listed Mississippi as their state of residence (see Figure 1).

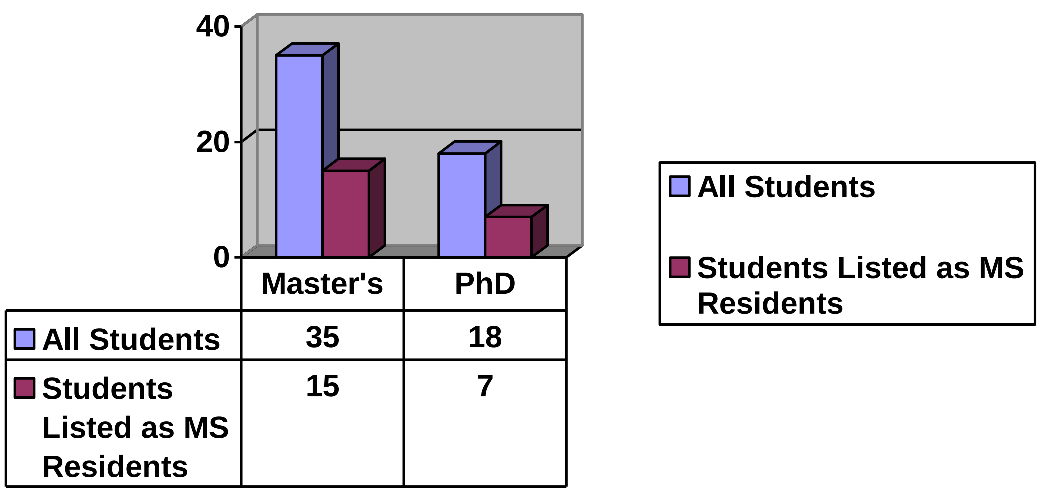

Figure 1. University of Mississippi physics graduate degree recipients from Fall 2003 semester through Full Summer 2012 semester (by residence status as officially listed in the statistics provided by the University of Mississippi Graduate School).

A portion of these students who listed Mississippi as their state of residence did so for convenience reasons or for other reasons than actually being a born, raised, and educated in Mississippi. The researcher verified this by discussing this issue with a few of the graduate students who were among those in the statistics (shown in Figure 1). Thus, the actual number of Mississippi natives (where "native", in this context, means being born, raised, and educated in Mississippi) is lower than that which is implied by the officially listed residence statuses; again, this is due to the fact that not all of the people who list Mississippi as their state of residence were actually born, raised, and educated in Mississippi. The knowledge of this fact elevates the concern among those who hope to see native Mississippians—who are probably more likely stay in the state—become educated as professional physicists.

The researcher, having spent much of his life in the field of physics (either as a student or as an instructor), was naturally interested in the success of physics education in Mississippi, which is the native state of the researcher. Naturally, the researcher's own observations concerning the relatively low number of truly native born Mississippians in the field of physics, as well as the data from the graduate school statistics, helped give motivation for the researcher to inquire even deeper into the reasons that so few native Mississippians graduate with PhD degrees in physics (or even other graduate level degrees in physics).

At first glance, one would expect that if Mississippians are performing relatively poorly at the highest level of physics, then perhaps it is in the high schools where Mississippians are not choosing to take physics or are not receiving adequate training in physics. Perhaps Mississippians should examine whether or not they are producing enough certified high school physics teachers. According to Susan White and Casey Langer Tesfaye, who wrote a November 2010 online article for *focus on* (a publication of the American Institute of Physics Statistical Research Center), "46 % of the teachers who taught physics courses in U.S. high schools in 2008-09 had a degree with a major or minor in physics or physics education" (2010, p. 4). Evidently, the majority of U.S. high school physics teachers actually majored in another subject area. However, according to White and Tesfaye (2010, p. 5), the finding that "less than half of the teachers who teach high school physics have a degree in physics or physics education" does not necessarily "imply that the teachers are not qualified to teach physics." According to White and Tesfaye, "It is likely that some of the non-degreed physics teachers...liked it enough to seek additional professional development that did not lead to a formal degree" (2010, p. 5). Nevertheless, there is probably still room for improvement when it comes to developing a fully qualified physics teaching workforce in U.S. high schools. Thus, any research study that will help shed light on the problem of physics education would be useful for all Americans (and indeed, useful for anyone around the world who is deeply interested in the quality of science education).

The researcher wanted to design a research study that gathered a wide variety of data from many areas—both qualitative (written survey answers, interviews, and transcripts) and quantitative (descriptive statistics from surveys)—which would help assess the state of physics in Mississippi, especially at the University of Mississippi. Hopefully, the results of this research will help Mississippians (and others) to better understand some of the deeper reasons why there are so relatively few native Mississippians who receive graduate degrees in physics. The researcher hopes that by better understanding physics and physics education in Mississippi, people from all around the world might better understand physics education in their own states and countries. Thus, although the researcher realizes that this research study might be especially interesting to people from the state of Mississippi (and surrounding, culturally similar states), the results of this research should be beneficial and useful to people everywhere. The researcher intentionally researched certain topics in physics education that would be interesting to people from all countries. Thus, this research study should have universal appeal and usefulness to all people who wish to better understand physics education (or science education, in general).

Problem Statement

According to data available from the graduate school at the University of Mississippi, relatively few native Mississippians are receiving graduate degrees in physics at the University of Mississippi—and this is especially true for the doctoral degrees. The problem becomes even more acute if one realizes that not all students who are listed as "Mississippi residents" are actually native Mississippians who were born, raised, and educated in the state (and thus would more likely remain in the state); some students move to the state fairly soon before entering graduate school, and establish Mississippi residency some time around this time period—whether they establish residency before or after they are enrolled in graduate school, the researcher cannot say with certainty. But, even if one adheres simply to the official graduate school statistics (which includes students who established Mississippi residency around the time of moving there to attend graduate school or possibly some time after they were in graduate school), the number of doctoral degrees awarded to native Mississippians is still relatively small when compared to the number of doctoral degrees awarded to non-native Mississippians.

One could surmise that either native Mississippians are not performing well in the graduate physics program at the University of Mississippi or they are simply choosing not to enter the graduate program for physics at the University of Mississippi. Perhaps they are attending other graduate schools around the nation or world. Of course, there could possibly be other reasons for the relatively low number of native-Mississippian graduates in the physics graduate program such as certain requirements to which the graduate programs must adhere to. Though more research would be needed to be achieve a high degree of certainty on this point, it appears to the researcher that the fact that a low number of native Mississippians are receiving graduate degrees in physics at the University of Mississippi could possibly be contributing to a self-defeating cycle; a cycle in which few native-Mississippian experts in physics are produced; a cycle in which there are few native-Mississippian physicists who can serve as role models and instructors for other Mississippians who wish to become competent physics majors or physics PhD students (see Fig. 2).

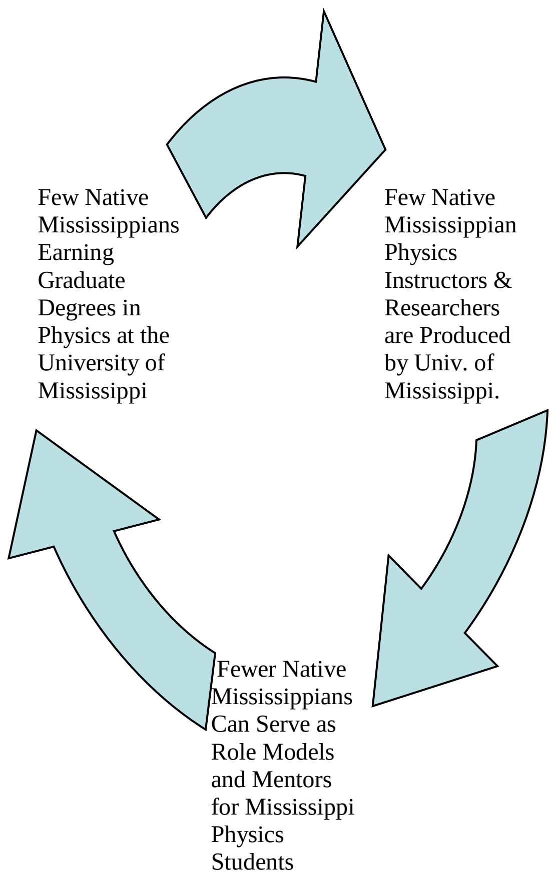

Figure 2. The figure above is a pictorial representation of a possible cycle which might be working counter to the production of native-Mississippian physicists.

Professional Significance of the Research

Public, state universities receive funds from the state in which they reside. Therefore, one would expect such universities to feel an obligation to make direct academic contributions to the state in which they reside. It seems only natural that one of the goals of public universities, among many other lofty goals, would be to increase the scientific competence of the students who live in that particular state. Public universities charge extra tuition to out-of-state students. One reason public universities do this is to be certain that they, as a first priority, educate the students of their own state. Apparently, they want to be certain that they have a large pool of native Mississippi students before they begin extending educational opportunities to the students of other states and countries.

Another way the state can help its native residents is by offering scholarships to students who show scholarly promise. For example, in the past, Mississippi has offered Mississippi Tuition Assistance Grant (MTAG) scholarships to those native Mississippians who show a certain level of scholarly performance. Each state benefits from having an educated populace of native students. It is the native-born students who will be the most likely to stay in the state and to continue to work in the state. Thus, state universities often cater to native students before branching out to serve students of other states and countries.

At the beginning of this study, it seemed to the researcher that Mississippi public universities had done a better job of educating native Mississippians in many other subjects than they had done in educating them in physics. Indeed, if one examines the specific subject area of physics, one will find a very low number of native Mississippians who are pursuing graduate degrees in physics—at least, this was true during the time span of the statistics involved in this dissertation (Fall 2003 semester-Full Summer 2012 semester) and during the time span during which the researcher worked or was a student in the physics department at the University of Mississippi.

Physics is one of the foundational subjects of the physical sciences. A competency in the subject of physics gives a student the academic tools to succeed in many other academic disciplines. Thus, if Mississippians wish to increase their academic competence, it is important that they improve their ability to educate Mississippi students in physics. To do this, it is important for Mississippi universities to produce an adequate number of people in the state who are educated at a high level in the subject of physics.

This particular research dissertation has been designed to deeply and widely study the various reasons why so few Mississippians are receiving graduate degrees in physics. The researcher hopes that the results of this study will be useful to Mississippians but also useful to people from any other state or country who wish to better understand physics education and who wish to improve the level of physics education. Although this research project would likely be the most useful to people specifically in the field of physics or physics education, this research project—due to the fact that it is so broad—should also provide a unique perspective to people in many fields of science education.

Some Cultural Issues which could Influence Physics Education in Mississippi

The relatively low number of native Mississippians who receive graduate degrees in physics is also in conflict with the fact that Mississippians have made many efforts to increase their competency in science education. If one reviews the literature on the topic, one will find that Mississippians have made many notable attempts to improve the level of physics education in Mississippi (see Appendix B). Also, the physics departments of Mississippi's colleges and universities have, in a number of examples, made valiant attempts to reach out to their surrounding communities. Perhaps there are deeper reasons for the low number of Mississippi physicists which cannot necessarily be remedied by the attempts that Mississippians have made so far to improve physics education—and thus, new and differently designed efforts must be made. The researcher was interested in perhaps better understanding why so much effort, energy, and money has still not produced much fruit (at least, when it comes to producing a high number of native Mississippian physicists).

In an attempt to deeply study the main factors that might influence physics education in the state of Mississippi, the researcher also needed to examine some cultural factors—and the answers to some of the cultural-related questions might also have universal appeal for people in other states and countries. There are a number of cultural factors (see Appendix A) which might help explain, at least partially, why Mississippians have apparently been at a disadvantage when it comes to education.

Mississippi educators face special problems, many of which are deeply rooted in the state's cultural and academic history. Consequently, if one wishes to properly interpret educational data in Mississippi, one must have a good understanding of the historical/cultural factors of the people who reside in the state. Thus, the researcher reviewed a large amount of historical literature in an effort to better understand some of these historical factors, and the researcher has included much of this historical/cultural information in the Appendix A.

The researcher originally had hoped to pursue some of these cultural/historical factors more deeply. However, a deep historical/cultural research project fell outside of the scope of this particular research study which was focused more toward the science educational aspects of physics. Yet, the researcher did include some information about some of these historical/cultural factors in Appendix A. The researcher also included a few questions in the survey forms which address some cultural factors. The researcher hoped that the answers to these questions would reveal some descriptive information which might shed more light on a few of these cultural factors.

However, outside of the historical research which was conducted, the major goal of this research was to provide a broad of assessment of the underlying factors which affect physics education in Mississippi, and thus to provide a deeper understanding and a better starting point for those who wish to improve the level of physics education in Mississippi. To do this, the researcher conducted surveys with a sample of 113 physics students and with a sample of 16 physics instructors. The researcher also conducted interviews with physics students and physics instructors or research physicists in order to more deeply understand their views, and in order to answer some questions about physics education. The researcher recorded the interviews, and carefully transcribed them into text. From these transcripts, much interesting information can be obtained. The researcher also analyzed parts of these interviews by breaking the interview answers into themes. The results of that research also provide much information. The researcher hopes that the results of this very broad research study will help Mississippians, but also citizens of all other states and countries, gain a deeper understanding of physics education and education in general.

Overview of Methodology

In order to fulfill the main the purpose of this research, the researcher conducted a an analysis of data from the University of Mississippi graduate school in order to determine how many Mississippi students, since the Fall semester of 2003 up through the Full Summer semester of 2012, have received graduate level physics degrees at the University of Mississippi; the researcher also obtained similar data from graduate schools at the universities of several other states (some neighboring states and some states from other regions of the country). The universities which participated in this study (by providing relevant data from their graduate schools) were as follows: the University of Alabama, the University of Arkansas, Louisiana State University, the University of Minnesota (Duluth), the University of Minnesota (Twin Cities), and the University of Virginia. The data provided by these universities covered time spans which were similar to—but not necessarily exactly the same as—the time span for which the graduate statistics from the University of Mississippi covered. The exact time span covered by each university's graduate school data is shown on in the respective results tables for these universities. The researcher hoped that the data from graduate schools of other universities might help provide a measure of how the University of Mississippi compares with universities from other states when it comes to educating its in-state resident students in graduate-level physics.

The researcher also wanted to compare the ratio of Mississippi residents to non-Mississippi residents who have received graduate degrees in other subjects during the time span from the Fall 2003 semester through the Full Summer semester of 2012 at the

University of Mississippi. The eight graduate-level subjects (or majors) at the University of Mississippi which the researcher compared for this dissertation research were as follows: Chemistry, Business, Accountancy, Engineering Science, History, English, Mathematics, and Physics. The researcher compared these various subjects by analyzing data provided by the University of Mississippi graduate school for each particular subject, and then calculating the percentage of the various graduate degrees (in these subjects) that went to "in-state" residents (i.e. those who were officially listed as Mississippi residents). Strictly speaking, a percentage was obtained (i.e. the percentage of graduate degrees that were awarded to MS residents) rather than an actual numerical ratio.

The researcher also conducted a survey with a sample of 113 physics students at the University of Mississippi. The surveys were conducted among five separate physics labs during the beginning few minutes of lab. It took roughly 15 minutes for the surveys to be given in each lab.   The five labs consisted of three Engineering Physics II labs and two General Physics II labs at the University of Mississippi. (Note: In this context, the "Engineering Physics classes are the calculus-based classes often taken by future scientists and engineers; and the "General Physics" classes are the trigonometry-based physics classes often taken by pre-med and other students interested in medically related fields, and this class is sometimes called "Pre-med Physics.") The surveys were given on two separate occasions: July 24, 2012 (for two labs) and April 24, 2013 (for three labs). This was done so that the there would be a mixture of views from both the summer school (i.e. summer semester) students and some views from the spring semester students. The questions on the survey instrument (i.e. survey form) were designed to gain demographic information, to measure the attitudinal opinions, and to measure other pertinent information concerning the students' educational background and their experience with the subject of physics. The survey contained 9 questions in the demographic section, 16 multiple choice questions, and 4 short-answer questions.

During the time period when the surveys were given, the researcher also asked for student volunteers who would be willing to stay and do interviews after the lab was over (or who would make an appointment to meet for a later time to do an interview). In this way, the researcher was able to conduct interviews with ten of these physics students at the University of Mississippi. The interviews varied in length of time, but they usually lasted somewhere between 5 or 10 minutes. The interviews were audio recorded, and then they were transcribed by the researcher at a later date. The researcher hoped that by interviewing the students, he might find differences and commonalities between Mississippi physics students and physics students from other states or countries.

The researcher also conducted surveys with physicists (i.e. physics professors, former physics professors, or research physicists) from the University of Mississippi, from Mississippi State University, and from the University of Southern Mississippi. The surveys (which consisted of a survey form) were given to a total of 16 physicists who were either physics instructors or research physicists. This survey form, which was titled, *Mississippi Physics Education: Instructor Survey Form*, consisted of 7 questions in the demographic section, 9 multiple choice questions, and 3 short-answer questions.

The researcher also conducted audio-recorded interviews with 17 physicists. These interviews, which were audio-recorded, were conducted in an effort to provide researchers with a deeper understanding of the perspectives of physics professionals who work (or once worked) in the state of Mississippi. The researcher transcribed these interviews and broke them down into themes in an attempt to more carefully analyze answers the physicists gave to various interview questions.

Out of the 17 physicists who participated in the interviews, 5 of them were classified as “native Mississippian” physicists, meaning that they were born and educated in the state of Mississippi; however, in one of these cases of “native Mississippian” physicists, the physicist moved to Mississippi as an infant rather than actually being born here. The researcher conducted interviews with the 5 native Mississippi physicists in order to record certain aspects of their views of physics, as well as certain aspects of how they, as native Mississippians, overcame the difficulties of becoming professional physicists. The researcher hoped that the transcriptions of these audio-recorded interviews with native Mississippi physicists might provide deeper insight into physics education in Mississippi. The researcher also hopes that these native Mississippi physicists might possibly serve as examples and role models for future Mississippians who wish to pursue a career in physics.

Research Questions

There are several questions which this particular research study will attempt to address. The major quantitative research questions are as follows:

- Since the Fall semester of 2003, what percentage of the physics graduate degree recipients at the University of Mississippi were classified as Mississippi residents?

- Since the Fall semester of 2003, what percentage of the graduate degree recipients in other graduate degree programs (such as Chemistry, Math, History, English, Business, Accounting, Chemical engineering, Electrical Engineering, and Mechanical Engineering) at the University of Mississippi were classified as Mississippi residents?
- Since the Fall semester of 2003, what percentage of the physics graduate degree recipients at neighboring universities (such as the University of Alabama, Louisiana State University, the University of Arkansas, the University of Florida, and the University of Tennessee) were classified as in-state residents?
- Since the Fall semester of 2003, what percentage of physics graduate degree recipients at traditionally high-performing universities (such as New York University, the University of California at Berkeley, the University of Minnesota, the University of Colorado, and the University of Virginia) were classified as in-state residents?
- Approximately what proportion of Mississippi high schools offer physics to their students, and has this proportion changed dramatically over time?

There are also a few research questions which are of a more qualitative nature. The student surveys and the interviews with the physicists will provide information that can be used to make comparisons with results found from the review of the literature. The qualitative data, from the surveys and interviews, will serve to explore (in a qualitative sense) the following basic questions:

- What are some of the physics attitudinal factors held by physics students at the University of Mississippi, especially as concerns their views toward their own ability to be competent physics students (i.e. their physics self-efficacy views)?
- Do physics students at the University of Mississippi have any commonalities in attitudes toward their self-efficacy beliefs in physics as students from other states or countries?
- Do physics students at the University of Mississippi enjoy the subject of physics? Do their answers to this question show commonalities with the views of students from other states or countries (as documented in the literature)?
- What are the reasons that students at the University of Mississippi give for pursuing (or not pursuing) physics degrees?
- Are there any similarities between the physics self-efficacy views of physics instructors and the physics self-efficacy views of students at the University of Mississippi?
- What are the opinions of physics professors at the University of Mississippi concerning the problems that are faced by Mississippi students in physics?
- What are the opinions of physics professors at the University of Mississippi concerning how Mississippians can improve physics education in the state?

- What are the opinions of successful native Mississippi physicists concerning difficulties faced by Mississippians in physics and how these difficulties can be overcome?

Benefits of this Research to Society

The results of this research will aid those who wish to diagnose some of the problems concerning physics education in Mississippi; it also provides detailed information which can be used to design possible solutions to the problems that exist in physics education in Mississippi. Indeed, this research provides a wide range of information that can be useful to educators in any state or country who wish to improve their level of physics education.

CHAPTER 2: LITERATURE REVIEW

Physics: A Beautiful, Useful, and Empowering Science

There are many reasons that one might choose to major in physics. The physicist Hugh Young (1992, p. 2), in his book *University Physics*, gives two main reasons to justify studying physics: (1) the basic science associated with physics is foundational to all engineering and technology, and (2) physics appeals to our sense of beauty. The usefulness of physics can be seen in many of the modern appliances that decorate our homes and cities. For example, the electric motors which are used in so many appliances would not have been possible without the work of the physicist Michael Faraday. Of course, Nicola Tesla, the profound inventor and electrical engineer, also utilized principles of physics in his work which was important in developing a type of electric motor based upon the concept of rotating magnetic fields. Tesla also conducted world-changing work with wireless energy and AC electrical transmission systems.

Theoretically speaking, it was the physicist James Clerk Maxwell who unified the theory of electromagnetism in a set of beautifully elegant equations known as Maxwell's Equations. The physicist Heinrich Hertz was the first to experimentally detect the electromagnetic waves which were predicted by Maxwell. Indeed, visible light was discovered to be a special case of electromagnetic radiation. In modern society, electromagnetic radiation is used in a number of applications, such as X-ray machines, microwave ovens, and wireless devices. Without the work of physicists, many of the technological devices which use X-rays, microwaves, radio waves, infra-red rays, and other electromagnetic waves, would not have been possible. In fact, it is seems almost superfluous to even discuss examples of the usefulness of physics, because we are surrounded by a tremendous number of modern technological devices—mechanical, electrical, thermal, acoustical, or optical—which were designed by people who were familiar with the basic laws of physics.

Yet, the usefulness of physics is not the only reason that it is important. Physics possesses a charm and beauty that has fascinated humans over the centuries. It is very common to hear physicists describe a certain physics equation as "elegant" or "beautiful." Indeed, there is a beauty associated with the finely developed learning needed to demonstrate some of the intricate physics proofs. Many physicists are attracted to the subject due to its inherent beauty. James Gleick (2003, p. 4) records a famous, oft quoted statement of the great physicist Isaac Newton. Newton said, "I don't know what I may seem to the world, but, as to myself, I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me." Newton's quote expresses his wonder at the fascinating beauty of the laws of nature. Other physicists have expressed an almost religious fascination with studying physics. A widely quoted saying of Albert Einstein is, "I want to know God's thoughts. The rest is details." Yet, there are still other reasons to study physics, besides just the usefulness and aesthetic beauty of physics.

Although we often think of certain military aspects of atomic physics, the role of atomic physics is not confined to such ghastly and undesirable arenas of life, such as war and nuclear destruction. In fact, atomic physics is extremely important in a more peaceful sphere of life: namely, the production of vast amounts of electrical power for society through the means of nuclear power plants. Yet, nuclear power plants are intricate and complex, and they are potential safety hazards if not maintained properly. Nuclear physicists and nuclear engineers are necessary to assure that such nuclear power plants operate safely.

Unless the nation continues to possess a talented pool of physicists, the nation cannot maintain a functional nuclear energy program for itself; the nation would therefore lose its self-sufficiency. The modern theories of atomic and nuclear physics are foundational to any nuclear energy program. In order to have a talented pool of physicists, the nation must have an educational system that can produce a high quantity of talented physicists.

It seems that having a talented pool of highly educated physicists would be an important priority for any political leaders who desired their state or nation to be self-sufficient. It is a reality that educational priorities are often linked to political priorities. At times, education becomes a “political endeavor fashioned by those in power” (Goldman & Aldridge, 2007, p. 1). Science is an integral part of a modern education, because science is an integral part of modern society. The importance of science to society can be gauged by the tremendous amount of money that political bodies appropriate for science (Hirsch & Weber, 2002). Science affects politics; politics affects science.

Physics has arguably become the most important of the sciences. According to Steve Fuller (2000, p. 99), physics is now held to be the "ultimate science of matter." Fuller, went on to describe how new scientific discoveries, such as the discovery of Brownian motion by Einstein in 1905, helped physics rise to the pre-imminent position in science—dominating all other sciences, including chemistry (Fuller, 2000). Nowadays, chemistry—which according to Fuller is often underappreciated—is often relegated to being described as a special field of "applied physics."

Fuller's book, *Thomas Kuhn: A Philosophical History for Our Times*, was written, in part, to expound upon the philosophies of Thomas Kuhn—a well-known philosopher of science. Kuhn, also a science writer, penned one of the most influential 20th century books on science philosophy: *The Structure of Scientific Revolutions*. In his book, Kuhn (1996) describes how scientific revolutions can occur in a similar manner to political revolutions; they occur when, one by one, people are converted to the new theory because it describes the scientific phenomenon better. These scientific revolutions cause paradigm shifts; they cause us to view the world through an entirely new lens. For example, humans once thought that the Earth was a fixed body at the center of the universe. They thought that the Sun, Moon, stars, and planets all revolved around the Earth. They developed intricate models to describe Earth-centered astronomy. However, the theories of Copernicus, which achieved gradual acceptance, changed the paradigm from which astronomers viewed their science. Copernicus had shown that the measurements of astronomy better accorded with a model in which the Earth and the planets all revolve around the Sun; only the Moon revolves around the Earth. This new paradigm caused scientists to readjust their old theories of astronomy. The concept of "paradigm" is often associated with the most well-known parts of Kuhn's theory (Hoyningen-Huene, 1989/1993).

New paradigms of thought, according to Kuhn (1996), often occur when there is a growing consensus among scientists that the "old view" does not work properly; often there are people who are zealous for the new theories, people who must be convinced, and people who hold on to the older theories until death. In time, if enough people are converted—whether through clearly demonstrated logical reasons or through the social pressure of the rest of the science community—a new theory will have taken hold. A new paradigm will have been installed. Paradigms can be changed, over time, after new scientific knowledge is learned and disseminated. It seems that just such a paradigm shift in science has occurred, so that now it is physics—not chemistry or any other science—which is most widely accepted to be the most fundamental of the sciences. Fuller (2000), implying such a paradigm shift, explains that since the early part of the twentieth century—and up to the present time—physics has acquired the status of being considered "the indisputable foundation of the sciences" (p. 102).

Some Reasons Why Students Choose Not to Major in Physics

Having reviewed some of reasons physics is considered to be an important subject, it is also necessary to review some of the reasons why students do not major in physics. There are a large number of students who do not have good perceptions of physics and who do not have a high appreciation of physics. A study of Dutch ninth-graders showed that physics and chemistry were the least liked subjects (Taconis & Kessels, 2009, pp. 1121-1122), with physics being "significantly less popular than all other subjects." Perhaps if educators can understand the negative perceptions that students have concerning physics, they can better understand how to change student perceptions so that more of them might study physics.

Perhaps one reason that students have bad perceptions of physics is because the subject is difficult and may result in bad grades. A study conducted by Taconis and Kessels (2009, p. 1121) showed that the grades of the students for physics were "significantly lower than for all other subjects." Thus, it is not surprising that Taconis and Kessels found that physics was ranked as the least-liked subject by students. Tyler (2007, p. 15), paraphrasing a review of student attitudinal interview studies by Terry Lyons (2005), listed "the unnecessary difficulty of school science" as one of the "key themes" which the Lyons' review indentified among the negative attitudes students have toward science.

Often, students are concerned with maintaining high grade point averages, so the possibility of making a low grade can deter them from taking physics. Perhaps teachers should re-evaluate their grading policies to be sure they are user-friendly to students. In other words, perhaps teachers should design the course so that a high grade is realistically possible. Teachers could consider giving a variety of easier activities—which would result in higher grades—to go along with the more difficult assignments. Another way that teachers can make the course less frustrating for students is to consider giving more credit for activities that the class does together. Also, teachers can look for ways to reward students with bonus points or extra projects—assignments that the students realistically have a chance to do well on. In such a way, perhaps, science teachers could keep their students from developing negative attitudes toward their subjects. Physics teachers must be careful not to make the course unnecessarily difficult for students.

A separate study, comparing 63 German eleventh grade students' attitudes toward the subjects of physics and English showed that the more students associated the word "difficult" with physics, the more negative their view was towards physics (Kessels, Rau, & Hannover, 2006). In other words, it seems that students who think physics is difficult also have negative views of physics. This leads one to consider the possibility that perhaps one of the major reasons that students do not like physics is simply because it is difficult.

Another study, discussed in the article *What Makes Physics Difficult?* by Ornek, Robinson, and Haugan (2008), was designed, in part, to discover various reasons that students found physics to be difficult. Approximately 1400 students, in an introductory physics class at Purdue University, were given a survey in which they wrote free responses to two simple questions: (1) "What makes physics difficult?," and (2) "What can be done to overcome these difficulties?" (Ornek et al., 2008). Once the researchers obtained the answers, they analyzed all the answers (in a search for themes) and divided up all the answers into three major themes: *student-controlled factors*, *course-controlled factors*, and *factors related to the nature of physics*. Under each theme, they put ten categories which represented the "ten most popular items in each of the three categories" (Ornek et al., p. 31, 2008). Then, they gave the survey to about 400 students in the spring semester (293 actually replied). They also gave the survey to 20 teaching assistants (or TAs) and to 4 physics faculty members.

Under the theme *student-controlled factors*, the top three reasons chosen by the students, as to why physics is difficult, were as follows: (1) “lack of motivational interest”, (2) “not studying more”, and (3) “not reading the textbook” (Ornek et al., 2008, p.31). Perhaps if teachers emphasize to students how important physics is, for the empowerment of the community and nation, the students will begin to develop higher motivation levels so that they will study and read more. One could argue that all three of these choices might be indicative of student boredom with the material. One could argue that a bored student would be less likely to enjoy reading the textbook or to enjoy studying the material; thus, reading and studying might be neglected by the bored student. Another explanation, for this finding, is that the students may have schedules which do not allow them the necessary time to study properly or read the textbook thoroughly. A third possibility, and a very real possibility, is that the physics courses cover an unrealistic amount of information for one semester—so that even conscientious students cannot realistically complete the necessary reading. In such a case, physics teachers and physics departments would need to consider breaking their courses into more parts so that each semester contained a more realistically digestible amount of material; this would allow the conscientious students the proper time necessary to read the textbook. Otherwise, their students may develop a dislike for physics and will choose other career paths.

Upon analyzing the *course-controlled factors*, Ornek et al. (2008, p. 32) found that the top three reasons chosen by the students, as to why physics is difficult, were as follows: (1) “too much work”, (2) “hard CHIP (Computer Homework In Physics) Homework”, and (3) “lack of consistency between the lab/tutorial/lecture and homework." These difficulty factors, chosen by the students, again indicate that teachers should pay attention to how much work they assign, being sure that the amount is realistic. Also, teachers should test out the computer homework to make sure it coincides congruently with the class material. A lack of consistency between the various parts of the physics course—such as between the lecture, tutorial, lab, and homework—would likely cause confusion and frustration. The teacher should also make sure not to assign too much computer homework, which is arguably easy to do since the computer programs often grade the computer work. An excessive and unrealistic amount of computer assignments would likely add to the students' frustrations. Such frustrations may account for some of student's negative attitudes toward physics.

The last theme analyzed by Ornek et al (2008) was the theme labeled as *factors related to the nature of physics*. When they analyzed this particular theme, Ornek et al. (2008, p. 33) found that the top three reasons chosen by the students, as to why physics is difficult, were as follows: (1) physics is cumulative, each concept builds upon the next (2) "physics is a very difficult subject", and (3) "there is too much material to learn." Some of these factors are rather hard for teachers to change since they are related to the very nature of physics. However, one thing teachers can do is to give the students enough time for the required work, if at all possible. In other words, teachers should, as much as possible, try to be sure that the work they assign can be realistically completed considering the time constraints and educational background of the students. The teacher may need to spend extra time going over background material—even if less overall course material is covered. Physics departments should consider planning for such "in-class remediation."

The fact that physics is a cumulative subject is one of the main reasons that a good educational background, in the early years, is important. Students who have a good elementary school background in science and math can be expected to do better in the higher grades. Students who have an excellent science and math background in high school will find it easier to manage the physics classes in college—the cumulative aspect of the class will not be as troublesome if students have an excellent educational background in the early years. However, if the students do not possess an adequate background in the science and math subjects, they will find higher courses in physics to be much more difficult. They will spend vital time trying to make up for previous material which they did not learn. This, too, can be expected to cause students to lose confidence and possibly develop negative attitudes towards physics.

Despite the fact that the three most commonly chosen factors, related to the "nature of physics," imply possible background inadequacies, the students did not frequently choose the factor *physics cannot be learned without a good mathematics background* as a reason for their difficulties with physics—even though it was one of the ten listed factors (Ornek et al, 2008, p. 33). In contrast, the category *physics cannot be learned without a good mathematics background* was the most commonly chosen category by the faculty—the most common choice (for why physics is difficult) out of the group of ten factors related to the nature of physics. This indicates that faculty and students do not always agree on what makes physics difficult.

It is important to emphasize that 4 physics faculty members and 20 teaching assistants, along with the 293 students, were given the second survey with the three themes—ten factors under each of the three themes (Ornek et al., 2008). The choices of the faculty members, concerning what makes physics difficult, did not always match the choices of the students—or the choices of the TAs. In some cases, there were differences between the choices of all three groups—students, TAs, and faculty. This indicates that faculty members sometimes "forget" how it feels to be a student. In other words, they sometimes have difficulty placing themselves in the mindsets of their students. From the students' perspectives, the faculty members would likely be much better teachers if they could be sensitive to the reasons that students give for why physics is difficult.

It is common to hear science and math students say that they can learn better from their peers than from their teachers. One could guess that this might have to do with the fact that since teachers have much more experience with the subject, the concepts seem easier to them—thus they might be oblivious to certain misconceptions and difficulties that students have. It is likely that they sometimes have trouble seeing things from the students' perspectives; thus, they may have trouble bridging the gap of knowledge. Perhaps physics teachers can decrease students' frustrations if they make a concerted effort to study research concerning students' views of what makes physics difficult. Physics teachers could also discuss the issue with their students, possibly creating their own survey forms to explore the difficulties that their students are having. This would be an acceptable way for physics teachers to conduct action research. In such a way, they could obtain information which might improve their own teaching and which might improve their students' attitudes towards physics.

Another factor which might cause students to view physics negatively is the perception (by some students) that physics is too structured and does not allow them to have intellectual freedom. A study (Kessels et. al, 2006) of German 11th graders (N=63) found that there was a strong correlation between the perceived "heteronomy" of physics and negative attitudes toward physics. Heteronomy, for that particular study, was defined to be a "lack of intellectual freedom" (Kessels et al., 2006, p. 763). Thus, one can say that some of the students felt that physics stifled their independence or intellectual freedom. Perhaps this is due to the traditional teaching methods that are often used in physics. Physics class often require the coverage of a large amount of textbook material, much lecturing, much note taking—all of which factors lead teachers to use the more traditional teaching methods. Perhaps the heavy emphasis on note taking and lecturing is one plausible explanation for why some students associated physics with "heteronomy" or, according to Kessels and colleagues (2006, p. 763), a "lack of intellectual freedom."

Still another possible reason for the distaste that some students have for physics is their distaste for certain classroom activities that they associate with physics. Students, in general, prefer the constructive, "hands-on" activities, and they also enjoy activities that allow them to have the freedom for personal expression. Physics, as a rule, seems to be conducted according to the more traditional teaching methods which require much written work and note taking. A study by Owen, Dickson, Stanisstreet, and Boyes (2008) was conducted in order to measure students' affinities for different classroom activities and to measure how frequently students perceived those activities to occur in physics classrooms. The study used the completed questionnaires of 1288 students from seven different secondary schools in the northwest of England. The students, of both genders, ranged from Year 7 to Year 11. The study also examined students' views concerning which of the activities were useful for teaching physics. For the study, Owen and colleagues listed 13 classroom items, which the students were asked to rank on a Likert-type scale that ranged from -1.0, 0.5, 0, 0.5, to 1.0. The thirteen activities, which were ranked, were as follows (in no certain order of popularity): “working in a group,” “having discussions,” “acting out and role play,” “listening to explanations,” “watching demonstrations,” “doing experiments,” “making things,” “doing diagrams and drawings,” “puzzles, games, and quizzes,” “doing calculations,” “written exercises and worksheets,” “copying down notes,” and “writing poems and stories” (Owen et al, 2008, p. 118).

Owen and colleagues found that there are some relatively disliked classroom activities that are perceived, by students, to occur quite frequently in physics classrooms (Owen et. al, 2008). For example, out of thirteen choices, the students listed the following three items (in order from more frequent to less frequent) as the top three activities that occurred most frequently in their physics classroom: (1) “listening to explanations”, (2) “copying down notes”, and (3) “written exercises and worksheets” (Owen et al., 2008, p. 120). It is interesting to note that all of the previous three activities would be considered, by most people, to be traditional classroom activities. Another chart in the study ranked the 13 activities, from most-liked to least-liked classroom activities. The least-liked classroom activity, chosen by the students, was “copying down notes” (Owen et al, 2008). The next least liked classroom activity was “written exercise and worksheets.” The fourth least-liked classroom activity (of the 13) was “listening to explanations.” Even though the previous three mentioned activities were unpopular with students, these three activities were perceived to be the top three most frequent classroom activities in physics. This particular study previously mentioned indicates that many of the physics classroom activities which students perceive to occur most frequently in the classroom are some of the very classroom activities that the students dislike the most.

Perhaps this accounts for some of the negative attitudes that many students have toward physics.

Owen et al. (2008) also divided the thirteen classroom activities into four themes or categories: *constructive activities*, *written activities*, *social activities,* and *passive activities*. It is noteworthy that the top three disliked activities were *written activities*. The top two most-liked activities were *constructive activities*: (1) doing experiments and (2) making things. The third most-liked activity was labeled as a *written activity*: puzzles, games, and quizzes. However, one could argue that puzzles, games, and quizzes are also constructive and social rather than just written activities. In general, students rated the *written activities* lower than any other category when it comes to popularity with the students. Perhaps the students generally dislike the *written activities* because they are tiresome and burdensome. Perhaps some students associate such written activities with "lack of intellectual freedom" or "heteronomy" which was found (Kessels et al., 2006) to correspond with negative attitudes toward physics.

Also, it is possible that students find such written activities to be boring. Indeed, in their literature review, Owen et al. (2008) referenced a another study by Williams, Stanisstreet, Spall, and Boyes (2003) which found that the following three ideas are the predominant negative views that secondary students hold toward physics: difficult, irrelevant, and boring. Perhaps difficult, irrelevant, and boring is how some students view the written activities which were found to be relatively unpopular by Owen et al. (2008). In contrast, overall, the constructive activities, such as "experiments" and "making things," were the most-liked activities of the four categories (*constructive activities, passive activities, social activities,* and *written activities*). The activities of the constructive category were rated by the students to be the most useful, when compared to the other three categories, for helping students learn and comprehend physics ideas. It is possible that physics teachers sometimes forget how much students wish to learn through constructive activities; perhaps teachers can install more constructive activities into their classroom activities as a way to get their students interested in physics.

There are also social reasons for the relatively low popularity of physics, according to some researchers. It seems that most students are not, in general, attracted to those personalities that are associated with physics. The Dutch study conducted by Taconis and Kessels (2009) examined how students viewed their peers. The students were asked to rate their peers based upon which subjects of study their peers liked. The results of the Taconis and Kessels (2009) study indicate that Dutch students "see typical peers who favour science subjects (physics/biology) as less attractive, less popular and socially competent, less creative and emotional, and more intelligent and motivated than typical peers who favour humanities subjects (economics/languages)" (p. 1128). Based on those results, it seems that there could be negative social consequences for students who choose to study physics seriously. For, although the students associated physics with intelligence and motivation, they did not associate physics with popularity, attractiveness, and social competence.

Taconis and Kessels (2009), who were trying to verify the "self-to-prototype theory" also found evidence that students do not like science because their self-image does not match up with the prototype of a person who has science as a favorite subject. In other words, the students' self-images do not coincide with the typical mental image that they have for a person whose favorite subject is science. Taconis and Kessels (2009,

p. 1130) drew the conclusion that science educators must “indentify successful ways that allow cultural border-crossing for students with less ‘science-oriented’ identities.” In other words, educators must develop ways to help students see the value, with respect to the students’ own self-images, of being a scientist.

The concept of “self-image” is also important when it comes to understanding how females view physics. For the most part, researchers have discovered that females have relatively negative views towards physics when compared to males. Also, females do not, as a rule, enter into the physics profession as frequently as males. In the last few years, efforts have been made to attract females into the science professions, because females have, historically, been underrepresented in the science, technology, engineering, and mathematics (STEM) professions. Physics, a quintessential STEM profession, has always been, for the most part, a profession in which the majority of participants are males. One possible reason for female underrepresentation is that females do not seem to be as interested in the physical sciences. Murphy and Whitelegg (2006), in a comprehensive review of the literature concerning girls-and-physics, referenced a study by Johnson and Murphy (1984) to support their assertion that, “National surveys of science performance in England and in other countries established across ages that more boys than girls wanted to study physical sciences topics” (p. 289). Girls were found to be more interested in the biological sciences than in the physical sciences. A possible explanation for girls’ lack of interest toward physics is that the subject of physics is viewed to be a masculine subject by girls. In a comparison of girls’ views of physics and English, one set of researchers (Kessels et al., 2006) found that the girls identified physics as being a more masculine subject than English.

If girls view physics as a masculine subject, they are not as likely to feel that it is socially acceptable for them to enter into professions associated with physics. To remedy this situation, physicists and physics instructors should emphasize that knowledge is vital and useful to all members of humanity. According to Okruhlik (2001), there are certain important perspectives toward science that only women can provide. If physics instructors emphasize the unique contributions and perspectives that females can offer to physics, then perhaps more females will choose careers in physics. In such a way, they would be able to serve as role models for other females who desire to study physics.

In an analogous way, one could hypothesize that the exceedingly small number of Mississippians in physics professions provides few role models and little social incentive for Mississippians to enter the physics profession. Perhaps understanding some of the reasons that females are under-represented in the physics professions will help us gain insight into some of the reasons why so few native Mississippians are represented in the physics professions. Females have unique perspectives of life which they could offer to the physics professions and to the world of science. In a similar manner, Mississippians have unique perspectives to add to the world of physics and science. Due to many complex historical factors, cultural factors, academic factors, or other factors, there have been relatively few Mississippians who have been able to enter into the physics professions. Thus, Mississippians are perhaps in a special position to understand the difficulties of those members of relatively unprivileged groups who desire to gain competency in difficult academic fields such as physics.

American Science and Physics Education

The society we live in has become increasingly global. Computers, cell phones, and other such devices have made it possible for people to communicate with each other across the globe. Jet planes now travel across vast oceans in a matter of hours. Trains, automobiles, and airplanes easily traverse the distance that once separated people. The internet makes it possible to communicate instant messages to vast audiences. Many people now have access to the internet through their hand-held phones, so that they can connect to the internet almost anywhere. Economists now talk of world markets rather than just the market of a particular nation. Yet, with globalization comes greater competition between nations (Hirsh & Weber, 2002). Markets that were once isolated by the barriers of distance are not separated anymore. Americans must accept that globalization brings, in a certain sense, greater competition in many realms. American businesses must now compete with European businesses, Asian businesses, and so on. American farmers must compete with Chinese, Brazilian, and Russian farmers. American automobile manufacturers must compete with Japanese and European automobile manufacturers. And, in a sense, American universities and colleges compete with colleges and universities from other parts of the world. Modern universities, around the world, face an increasingly competitive environment due to globalization (Hirsch & Weber, 2002). According to Hirsch and Weber (2002, p. 35), "science and technology play a dominant role" in the modern university.

Science helps empower nations to become more productive and more self-sufficient. Thus, it is in the interest of the nation to maintain a competent science program. It can be argued that American scientists are among the top-tier of world scientists. American researchers still produce information that is at the forefront of knowledge. American scientists are still well-represented in the pool of Nobel Prize winners. American engineers still produce new products and inventions that astound the world. Yet, although America has a core of elite scientists that are unsurpassed in quality, there is still a sense that American education is weak. Science teachers (and others) often discuss how Americans must become more competitive in science so that they can compete with their international peers, especially as society becomes increasingly globalized. There is some basis for their worries. For, according to Eric Bettinger (2010), “over the last 40 years, the supply of US-born scientists and engineers has dropped dramatically” (p. 69). Bettinger (2010) went on to say, “In 1970, 3,547 US citizens received doctoral degrees in the physical sciences. By 2005, this number had fallen to 1,986” (p.69).

According to data from a July 2011 *focus on* article titled “Physics Graduate Degrees: Results from the Enrollments and Degrees & the Degree Recipient Follow-up Surveys” (Mulvey & Nicholson, 2011, Figure 1) published online by the American Institute of Physics [AIP] Statistical Research Center, the number of PhD degrees conferred in the U.S. to U.S. citizens has decreased during the years between roughly between 1967 through 2007. However, according to the same online AIP article (Mulvey & Nicholson, 2011, Figure 1), the number of PhD degrees conferred in the U.S. to non-U.S. citizens [i.e. foreign students] increased dramatically during that same time period from roughly 1967 through 2007. Indeed, by 2007, the number of PhD degrees conferred in the U.S. to foreign citizens had surpassed the number PhD degrees conferred in the U.S. to U.S. citizens.

According to Bound and Turner (2010), the continued increase in the number of foreign students in PhD departments may push out some American students who would have otherwise been awarded the slots. On a positive note, data (shown on the graph in the Mulvey & Nicholson study) for the number of PhD degrees conferred in the U.S. to U.S. citizens shows a notable upward trend from about 2005 up through 2008, which was the end of the time period which was measured by that particular graph (Mulvey & Nicholson, 2011, Figure 1). The data in that particular graph did not show any years later than 2008.

However, according to Mulvey and Nicholson (2011, para 1), these trends (concerning the rise and fall of the number of PhD degrees conferred) appear to have a cyclical nature. Mulvey and Nicholson (2011, para. 1), mentioned that there are cyclical changes that influence the number of PhD's that are conferred each year such as "changes in university budgets and science funding, economic cycles affecting the job market for physicists" and other important issues (some pertaining to international students and some pertaining to U.S. students).   Still, according to the data in the July 2011 AIP online *focus on* article (Mulvey & Nicholson, 2011, Figure 1), in 2007, the number of physics PhD's degrees conferred in the U.S. to foreign citizens was greater than the number of physics PhD's conferred in the U.S. to U.S. citizens. Of course, it must be mentioned that the graph in Figure 1 of the 2011 article by Mulvey and Nicholson did not show any years later than roughly 2008; the online article had a publication date of 2011.

In a more recent (February 2014) online article from AIP (American Institute of Physics) which also listed Mulvey and Nicholson as the authors, one can see how the trend has continued since 2008 (up through 2012). In this February 2014 online *focus on* article [*focus on* is a publication of the AIP Statistical Research Center] titled, "Trends in Physics PhDs", it appears that from 2008 up through roughly 2012, the number of PhD degrees conferred in the U.S. to U.S. citizens has continued to increase, so that by 2012, the number of PhD degrees conferred in the U.S. to U.S. citizens was again greater than the number of PhD degrees conferred in the U.S. to non-U.S. citizens (Mulvey & Nicholson, 2014, Figure 1). This recent upward trend in the number of PhD degrees conferred in the U.S. to U.S. citizens provides some hope to those who are interested in increasing the competency of U.S. students in physics; however, the data shown by the graph still demonstrated that in 2012, nearly half of the PhD degrees conferred in the U.S. went to non-U.S. citizens (Mulvey & Nicholson, 2014, Figure 1).

Another negative implication of the influx of foreign students into PhD programs is that American graduates will face vastly increased competition in the job market; for example, a PhD computer scientist from India will likely work for much cheaper than a PhD computer scientist from America (Freeman, 2010). Like their colleagues in computer science, American graduates in engineering, math, and physics can also expect to face strong competition, from foreign workers.

At the graduate school level, the competition from foreign students increases even more. For example, in an essay titled *What Does Global Expansion of Higher Education Mean for the US?,* Freeman (2010, p. 395) published a table using 2005 data from the National Science Board: the table showed that in 2005, foreign-born U.S. science and engineering workers represented 15.2% of the total share who had bachelor's degrees, 27.2% of the total share who had Master's degrees, and 34.6% of the total share who had Doctorate degrees. This data indicates that Americans face strong competition for academic-related jobs in the science and engineering fields; and the competition increases as the educational attainment level increases.

Since Americans who are in the science disciplines will apparently face strong competition in higher education and in the workplace, it is important that American students obtain the best science education possible. Yet, there is evidence that American students, when compared with the students of other developed nations, are falling behind. For example, in the PISA (Program for International Student Assessment) 2006 assessment of scientific literacy, American 15-year olds did not perform as well as the majority of the “developed nations” which participated in the study (Bybee, 2009, p.5). In the study, there were 30 countries, including the United States, who were members of the Organization for Economic Cooperation and Development (OECD). A great number of the 30 OECD countries—if not all of them—were countries which one would consider to be “economically developed” countries. For example, some of the OECD countries in the study were Finland, Canada, United Kingdom, Japan, Australia, Sweden, Germany, Italy, France, the United States (U.S.), and 20 other countries. There were also 27 non-OECD nations who participated in the PISA 2006 study, such as for example, Hong Kong, Chinese Taipei, Estonia, Croatia, Russia, Thailand, Brazil, Argentina, Israel, Slovenia, Bulgaria, and many others. In total, there were 57 nations in the PISA 2006 Science study of scientific literacy.

According to Bybee, “U.S. 15-year olds lag behind the majority of developed nations that participated in the survey” (2009, p. 5). Indeed, if one just observes the order of the scores in one of the tables (Bybee, 2009, Table 3) provided in the article, there were 20 other OECD countries (out of a total of 30) which had higher average scores than the U.S. on the PISA Science 2006. However, according to information stated on the table (Bybee 2009, Table 3) and according to other statements by Bybee, one can surmise that a few of these 20 countries' average scores were not measurably higher than the U.S. average score, statistically speaking. Apparently, there were, statistically speaking, 16 countries that had higher average scores—or "measurably higher" as stated in Table 3 of Bybee's article—than the U.S. average score. In Bybee's words, "Out of 30 OECD countries participating, 16 countries' average score was significantly higher than the U.S. average" (2009, p. 5). One thing was apparent: The U.S. scores on the PISA 2016 Science assessment were not in the top tier of scores when compared with the average scores of the other 30 OECD countries in the study. In fact, there were even a few (actually six) of the non-OECD countries which had an average score which was "measurably higher than the U.S. average" score (Bybee, 2009, Table 4).

According to the data provided by Bybee (2009, Table 3 and Table 4), the six countries which had the *highest* average scores out of the all the countries (including both OECD and non-OECD countries) were as follows: Finland (563), Hong Kong (542), Canada (534), Chinese Taipei (532), Estonia (531), and Japan (531). The six countries which had the *lowest* average scores (including both OECD and non-OECD countries) were as follows: Brazil (390), Colombia (388), Tunisia (386), Azerbaijan (382), Qatar (349), and Kyrgyz Republic (322). In terms of average scores for PISA 2006 assessment of scientific literacy, the U.S. 15-year-olds had the relatively mediocre score of 489. The above "ranking" of the six highest and the six lowest average scores for the various countries was only based on the raw average score values shown in Bybee's tables (2009, Table 3 and 4); thus, some of the scores which are similar to each other might not actually be significantly different from each other, statistically speaking. However, showing the order of the highest and lowest scores for the various countries does seem to give a good basic starting point for understanding how U.S. 15-year old science students compared with science students of other nations—at least, as measured by the results of the PISA 2006 assessment.

Data from the online report titled *Science and Engineering Indicators: 2010*, which was published on the website of the National Science Foundation (NSF), confirms that there is much work to be done to improve science education in US elementary and middle schools. One portion of the online report discussed the Trends in International Mathematics and Science Study (TIMSS:2007). The TIMSS study compared the TIMSS exams of U.S. fourth and eighth graders with the scores of students from other selected countries. In 2007, the scores of the TIMSS exams showed that U.S. students fell somewhere near the median of the other selected countries (National Science Foundation, 2010). And while the 2007 U.S. average math scores showed some relative improvement from the 1995 scores, the 2007 average U.S. science scores showed no measurable change from the 1995 scores (National Science Foundation, 2010). Thus, there is much work to be done by science educators if they want their U.S. students to excel. The NSF report concerning the 2007 TIMSS exams seems to show that if they were not falling behind, the U.S. fourth and eighth graders definitely were not excelling over their international peers.

From the standpoint of higher physics, it is important that, rather than waiting for the college years, young high school students begin advancing in their studies of math and science as soon as possible. Having well-qualified math and science teachers would greatly benefit such students. Having a well-qualified physics teacher would help a student build the foundation and develop the interest and motivation needed to pursue higher-level physics studies. Yet, many high school physics teachers in American schools are not certified to teach physics. In the 2004-2005 academic year, only about "33% of physics teachers had a major in physics or physics education and another 11% had a minor" (Hodapp, Hehn, & Hein, 2009, p. 41). These figures imply that a large number of teachers are not qualified—at least not certifiably qualified—to teach high school physics. Thus, it is likely that many young students will have to wait until college before they have access to well-qualified teachers. However, by that time it may be too late for the students to compete at the highest levels of physics. They will likely have already fallen behind their competitors.

The shortage in certified high school physics teachers has existed for a number of years and still exists; yet, recently there have been some promising developments that seem to indicate a way to increase the number of high school physics teachers. Hodapp et al. (2009) discussed many of these promising developments. For example, in 1999, the Physics Teacher Education Coalition (PhysTEC) was jointly formed by the American Physical Society (APS), the American Institute of Physics (AIP), and the American Association of Physics Teachers (AAPT) (Hodapp et al., 2009). PhysTEC began working with various colleges and institutions to develop solutions to the problem of not having enough certified high school physics teachers. Several colleges and universities participated with PhysTEC, and those colleges and universities have been designated as PhysTEC institutions. These PhysTEC institutions tried to put into practice many of the recommendations of PhysTEC.

One of the most promising solutions, utilized by PhysTEC institutions, is to let physics departments take over much of the responsibility for educating physics teachers. In the past, “Physics Education” majors took the majority of their classes in the education schools; and, after taking a few physics classes and a large number of education classes, they could become certified physics teachers (if they had passed the licensing tests). However, according to the recommendations of PhysTEC, physics departments are better suited to producing high quality physics teachers than are education departments. If physics departments coordinate their efforts with the education departments, they can likely produce a higher quality of physics teachers.

Also, physics departments can serve as a channel for steering promising future teachers into physics education. According to the authors, “a recent AIP study showed that almost half of the physics bachelors who became teachers received encouragement from faculty to pursue teaching” (Hodapp et. al, 2009, p. 41). In other words, positive and encouraging words from professors were found to be extremely productive in motivating students to become physics teachers.

A graph of the number of physics teachers certified, at the PhysTEC institutions, shows a dramatic increase in the years after the universities decided to become PhysTEC institutions (Hodapp et al., 2009). In other words, several universities (such as the University of Arkansas) saw a remarkable increase in the production of certified physics teachers after they implemented the solutions recommended by PhysTEC. The positive results experienced by the PhysTEC institutions should be examined by Mississippi colleges and universities so that, hopefully, they can begin to produce a higher number of certified physics teachers.

The positive results experienced by the University of Arkansas should serve as inspiration, not only for Mississippi, but for all colleges and universities in the American South which might have similar circumstances. Historically speaking, the states from the American South (sometimes called "Southern states") have probably not produced as many famous or renowned scientists as other sections of the United States. The Southern states, as a whole, have been subject to a number of historical and cultural factors which have possibly mitigated against their production of large number of high-quality science programs. Mississippi, which is one of the quintessential Southern states, a Deep South state, has been subject to many of the same educational disadvantages as the rest of the South. [However, the researcher—upon further reflection and study—must also mention that many other rural areas of the United States might experience many of the same educational disadvantages as the South. The researcher, while believing that the educational disadvantages experienced by the average student in the South are real, also believes that there are fundamentally deeper causes for many of these disadvantages (than just being from the South), and that these deeper causes can affect people in all states or countries of the world.]

Science Education and Physics Education in Mississippi

There is no shortage of documentation concerning the relatively poor performance of Mississippi, educationally speaking. *The Nation's Report Card*, an online report published by the U.S. Department of Education, shows that the 2009 NAEP (National Assessment of Educational Progress) science assessment scores of Mississippi 8th graders was the lowest of all 46 states (or jurisdictions) in the study. The report states that only

15% of Mississippi 8th graders scored at or above the *Proficient* level on the NAEP science assessment; in comparison, an average of 29% of students from the other states (or jurisdictions) scored at or above the *Proficient* level (U.S. Dept. of Ed., 2009).

Another online report, *Measuring Up 2008: The State Report Card on Higher Education (Mississippi)*, was published by The National Center for Public Policy and Higher Education. According to the online report, “the *Measuring Up 2008* national and state report cards on higher education were made possible by grants from the Bill and Melinda Gates Foundation and the Lumina Foundation for Education” (National Center for Public Policy and Higher Education, p. 17). This report, published in 2008, gave Mississippi a “D” grade on the *Preparation* index (National Center for Public Policy and Higher Education, 2008). The *Preparation* index was meant to measure “how adequately the state prepares students for education and training beyond high school” (National Center for Public Policy and Higher Education, 2008, p. 2). Only four other U.S. states scored a “D” or lower—in other words, Mississippi was in the bottom 5 states on the *Preparation Index* (National Center for Public Policy and Higher Education, 2008, p. 15). In another place, the online report (2008, p. 3) stated that Mississippi eighth graders “perform very poorly in math, science, reading, and writing.” These statistics lead one to conclude that Mississippi is producing, when compared with many other states, a smaller percentage of students who can perform proficiently in the sciences. This data gives evidence that by 8th grade, Mississippi science students are already falling behind their peers. Such students, who have already fallen behind their peers, will have great difficulty performing well in higher-level physics classes.

According to Westley Busbee, Jr. (2005), outside observers have given reasons for both optimism and pessimism concerning the future of Mississippi. Some of the reasons for pessimism have been heard for years by Mississippians. A few of the positive indicators mentioned were the state's "natural resources," the state's "human resources," recent "economic advances," and recent "educational" advances (Busbee, Jr., p. IX, 2005). Yet, there are other indications which point to an unhealthy education system, and a general pessimistic outlook. Busbee (2008, p. IX) writes that the pessimists will likely say the following about Mississippi:

> The state remains at or near the bottom of the fifty states in several important categories, including per capita income, adult literacy, and public health—and that lingering racial discord dampens hopes for real progress. (Busbee, Jr., 2005)

Among the list of concerns are "adult literacy" and "per capita income." A low adult literacy rate gives evidence that Mississippi education has lagged behind the education of other states. However, one might also hypothesize that numerous older Mississippians were part of a generation that was denied full access to education. Possibly, that could skew the data to give Mississippi a lower ranking than its educational performance actually merits. The low per capita income is indicative of a variety of other associated factors, such as a low relative standard of living, a lack of industries, and a poor educational system relative to other states.

At one time, in the distant past (1860), Mississippi was the "fifth wealthiest state in the Union" (Bass & De Vries, 1977, p. 190). However, after the Civil War, Mississippi "plummeted to the bottom" (Bass & De Vries, 1977, p. 190) of the states (economically speaking). A competent education system, especially in the sciences, will help Mississippians become competitive again. Research and development in the sciences could possibly produce new jobs for Mississippians; plus, talented people from other states could be attracted to the state.

A report by Nicole S. Poulin, from Peabody College of Vanderbilt University, accords with Busbee's list showing that Mississippi has a low per capita income. Poulin (2010, p. 80), referencing information from the 2008 U.S. Census Bureau, states that Mississippi's "median per capita income is the lowest in the nation at $36, 388." Poulin (2010, p. 82), citing a 2008 "Quality Counts" online report (from *Education Week*), says that Mississippi has the "lowest achievement scores based on No Child Left Behind accountability measures."

Although the researcher found some literature which documents the weakness of Mississippi Science education at the junior high (and possibly high school level), there is no literature—to my knowledge—that measures physics achievement at the high school level. During the literature review which occurred in the early stages of this research project, the researcher found no data that compared the various states in terms of physics performance at the college level. There seems to be a vast gap in the literature concerning measurement of physics performance in Mississippi. It seems that there is potential for much research concerning physics and physics education in Mississippi. At the time this research project was begun, even simple descriptive data—concerning Mississippi physics and physics education—was difficult or impossible to find. If it is so difficult to find data on Mississippi physics performance at the high school level and college level, it seems that statistics concerning graduate-level physics performance of native Mississippians would be even more difficult to find.

In the process of the literature review (prior to conducting the data-gathering research), the researcher found a couple of sources which could be applied generally to Mississippians in graduate school. For example, the online report *Measuring Up 2008: The Report Card on Higher Education (Mississippi),* contained the following statement concerning Mississippi graduate students:

> Mississippi is more than 48 percentage points below the national benchmark in preparing students for graduate study as reflected in graduate admissions examinations. Mississippi graduates are 30% more likely to take such examinations than are graduates on average nationwide, but the proportion earning competitive scores is 60% below the national average. (National Center for Public Policy and Higher Education, 2008, p. 11)

In short, it seems that Mississippians are eager to go to graduate school, since they are more likely to sit for the graduate admissions examinations. Yet, they do not score well. This is, in some ways, a tragic situation. It seems that Mississippians are very eager to obtain a good education and to serve their fellow men and women in the academic arena. Yet, it seems that at the highest academic levels, the path is often closed off to them due to a variety of factors that hinder their academic success.

A very old source indicates that Mississippi graduate students were, in years past, also thought to be unprepared for graduate school. For example, an excerpt from the 1954 report, *Higher Education in Mississippi*, states the following concerning graduate students at the University of Mississippi (in 1954):

> Interviews and the academic records of students support faculty opinion concerning lamentable inadequacies in previous preparation. Observations and the records of library and laboratory usage indicate that students do not have the habits, skills, and reasoning powers commonly associated with superior graduate study and research. (Brewton, 1954, p. 96)

The report, which was created by the Board of Trustees of the Institutions of Higher Learning (in Mississippi), went on to say that there were significant differences between individual students and individual departments [concerning the previously mentioned deficiencies] (Brewton, 1954).

Interestingly enough, the overall judgment of the quality of graduate students was not harsh, for the report stated the following: "These investigations led to the conclusion that resident graduate students at the University of Mississippi in the spring of 1954 were generally the equal of those at similar schools in the region" (Brewton, 1954, p. 95). With this statement, it seems that the report attests to the idea that the University of Mississippi's graduate students are not significantly different from the graduate students of other schools in the region. However, it does seem clear that some faculty members felt that graduate students at the University of Mississippi were unprepared for the academic rigors which faced them. To my knowledge, there is no current research on the matter of the prior preparation of graduate students who attend the University of Mississippi. It would be particularly interesting to study the prior physics preparation of Mississippi students who enter graduate school to study physics.

The evidence of the literature indicates that there is much work to be done by Mississippians in order to develop a higher quality educational system. The literature indicates that Mississippians have not performed well on science achievement tests or other national tests—such as those associated with No Child Left Behind. There is a vast gap in the literature concerning physics education in Mississippi. Yet, due to Mississippi's poor overall performance in the sciences, on other national tests, and on graduate admissions examinations, one can surmise that Mississippians likely are far behind their peers when it comes to physics achievement—for physics is one of the most difficult of all the academic subjects. Due to the difficulty of physics, one would expect educational inequities to show up in physics as much as in any other subject. The overall weight of the evidence lends credence to the idea that most Mississippi students do not have the necessary preparation to perform well in graduate level physics courses.

Despite the inadequate science preparation and performance of Mississippi students, one cannot conclude that Mississippians do not care about science. In fact, one of the most interesting things that the researcher learned from the review of the literature was the fact that Mississippians have made strenuous efforts to try to improve science education (see *Appendix B*). In a way, it is sad that despite all the efforts by Mississippians to improve science education, only a few Mississippians are obtaining graduate degrees in physics from the University of Mississippi—at least, this was true for the roughly nine-year time period over which the UM graduate school data for this research project measured. It seems clear to the researcher that Mississippians need to change some aspects of their high school educational system so that they, too, can produce more students who are prepared to be world-class physicists.

However, upon reviewing the data from other graduate schools, it seems to be implied that some other states—if one measures by the graduate school data from some of the other state universities in this study—also award a low proportion of their graduate degrees (in physics) to in-state residents. A larger sample size of universities (and states) would need to be included in future research studies to determine whether or not this is truly a general principle among all states and universities in the United States. The 2012 and 2014 online articles by Mulvey and Nicholson display evidence which suggests that there might be some general principles in operation which are resulting in large proportions of physics PhD's being awarded to non-U.S. citizens. These same general principles—whatever they might be—could be in operation at the University of Mississippi and at other state universities around the nation, too.

Summary of the Review of the Literature

The literature review provided evidence that Mississippians are, relatively speaking, behind much of the rest of the nation when it comes to science education. The literature review confirmed that there is a vast gap in the literature concerning physics education in Mississippi. The literature review provided evidence that, on average, American high school science students are in the median range when compared with science students from other industrialized nations—in other words, American science students are not in the elite group, and they are not in the bottom group of students either.

The literature review was almost blank, when it came to information concerning performance or attitudinal views of Mississippi physics students at the undergraduate or graduate school level. There was a little general data on Mississippians in graduate school; the recent data showed that Mississippi graduate students score lower than average on GRE tests; there was also an old report from over 50 years ago which showed that Mississippi graduate students of the past were also thought, by some faculty members, to be unprepared for the rigors of graduate school.

Despite the many aspects of the literature which illustrated the many obstacles faced by Mississippians in science education (see Appendix A), there was one overwhelming positive fact that emerged from the literature: Mississippians have made extraordinary efforts to create programs and organizations to improve their level of science and physics education (see Appendix B). This fact made the researcher more desirous than ever to search out possible solutions to the problem of why Mississippians do not seem fully prepared for the high-level math and high-level physics subjects which are pre-requisite to academic success in the graduate level physics programs. Hopefully, the surveys and interviews among Mississippi students and professors will shed more light upon possible solutions. Also, the analysis of the data from the graduate schools should also provide a good starting point for those who wish to study physics education among Mississippians. If nothing else, hopefully the research study will serve to raise awareness of a possible problem that might be addressed by those who are closer to the solution than the researcher. Hopefully, this research will form a seed upon which future research on the topic of Mississippi physics education may coalesce. The researcher also hopes that this research might help students from any state or country in the world.

CHAPTER 3: METHODOLOGY

General Overview of Methodology

The main sources of new information, for this research study, were as follows: (a) the data concerning residence statuses of graduate degree recipients from the graduate school at the University of Mississippi; (b) the data concerning residence statuses of graduate degree recipients from the graduate schools at several neighboring and high-performing universities (namely, the University of Alabama, the University of Arkansas, Louisiana State University, the University of Minnesota, and the University of Virginia); (c) the student survey forms (given to students at the University of Mississippi), which used multiple-choice selections and a few short-answer questions to measure student attitudes towards physics; (d) the multiple-choice instructor survey forms (given to instructors at the University of Mississippi, Mississippi State University, and the University of Southern Mississippi); (e) the interviews with ten physics students, which were meant to allow the students to more freely answer a variety of questions concerning their attitudes toward physics; (f) the interviews with twelve physics instructors or research physicists at the University of Mississippi, which were meant to allow the physics instructors to answer important questions concerning the performance of Mississippians in physics; and (g) the interviews with five successful Mississippi physicists which were meant to provide valuable qualitative information concerning the stories of some successful Mississippian physicists.

Procedures used for Data Collection and Basic Methods Used to Analyze the Data

As one of the first steps in this dissertation research, which received official IRB approval in the summer of 2012, the researcher requested data from the graduate school at the University of Mississippi concerning the resident status of students who have received graduate degrees in the subjects of chemistry, business, accountancy, engineering science, history, English, mathematics, and physics. The researcher obtained this data for the time period spanning the Fall 2003 semester up through the Full Summer semester of 2012. Using this data, the researcher calculated descriptive statistics to find out what percentage of the graduate degree recipients in these various academic fields were classified as Mississippi residents.

During the summer of 2013, the researcher began the process of contacting (via telephone or email) various graduate schools in neighboring states (or in some cases, in more distant states) in an attempt to obtain data from the graduate schools concerning the residence status of students who received graduate degrees in physics during the previous roughly ten years. The researcher wanted to use this data to compare with the data from the graduate school at the University of Mississippi. Although several universities' graduate schools (or related officials) were contacted, not all of them were able to participate in the study or provide the necessary data. However, the following universities (via the officials who were associated with the graduate schools) provided the data from their graduate schools: the University of Alabama, the University of Arkansas, Louisiana State University, the University of Minnesota (Duluth), the University of Minnesota (Twin Cities), and the University of Virginia. Once the data was obtained, the researcher calculated descriptive statistics to find out what percentage of physics graduate degree recipients at each university (during an approximately ten year time span) were residents of the particular state in which that particular university is located. In this way, the researcher hoped to obtain a descriptive measure which could be compared (descriptively speaking) with the percentage (and the number) of graduate degree recipients who were classified as "in-state" residents in the physics department at the University of Mississippi.

In an effort to obtain some qualitative and quantitative data concerning Mississippi physics students, the researcher gave an attitudinal survey form to 113 students on the campus of the University of Mississippi. The survey form had 20 questions which were meant to provide data concerning students' science attitudes and their reasons for choosing their particular major. At the beginning of the student survey form, there were 9 brief questions for obtaining demographic information, such as the student's age, gender, major, and so forth. The quantitative section of the survey form contained 16 multiple-choice questions, and the qualitative section contained 4 short-answer questions. The researcher gave the survey form to students who were enrolled in the Engineering Physics II and the General Physics II (i.e. Pre-med Physics II) labs at the University of Mississippi. Generally speaking, most of the students who are enrolled in the physics lab are also simultaneously enrolled in the physics class. The surveys were given on two separate occasions (July 24, 2012 and April 24, 2013) to five different physics lab classes. Three of the labs were Engineering Physics II labs, and two of the labs were General Physics II (i.e. “Pre-med” Physics II labs). The researcher chose two separate occasions to give surveys because it was desirable to have the views of both summer semester students and spring semester students. Two of the physics II lab sections were surveyed on July 24, 2012; from this survey occasion, the researcher obtained 38 completed (or almost completed) student surveys. Then, on April 24 2013, the researcher gave surveys to the other three physics II lab sections which participated in this research project; from this survey occasion, the researcher obtained 75 completed (or almost completed) student surveys.

The surveys were given during the first roughly 10 or 15 minutes of lab (give or take a few minutes). The researcher first made a brief announcement about the purpose of the surveys (i.e. that they were for a graduate student research project); the researcher also discussed other pertinent information about the surveys. Then, the researcher passed out the surveys. After a few minutes, the researcher picked up all the completed surveys. (And, in one case that the researcher remembers, a completed student survey was given to the researcher by the lab director perhaps a couple of hours later; apparently, this happened because the student had not completed the survey form at the time when the researcher picked up the other student survey forms, thus the student apparently gave the completed survey form to the lab director later who passed it on to the researcher some time later.) Ultimately, the researcher was able to obtain completed (or almost completed) survey forms for a total of 113 students. Many students of both genders were represented in the sample; a wide variety of ethnicities was also represented in the sample.

During the time the researcher was giving the surveys to the lab students, the researcher also asked for student volunteers to participate in interviews after the lab class—and the researcher also mentioned that he could schedule the interviews for another more convenient time that day to conduct an interview. Also, the researcher mentioned that he would wait in a nearby room (near the physics lab) if any students wished to volunteer for the interviews at that time—once they finished the lab experiment for that day. In this way, the researcher was able to obtain ten student volunteers to participate in the interviews, which were designed to be approximately 5-minute interviews. The interviews, which were audio recorded, were conducted in a private room (which is normally used as a research lab room) on the second floor of Lewis Hall, the physics building at the University of Mississippi.

It must be mentioned that the interviews with the 10 physics students was a convenience sample consisting of the 10 physics students who were willing to volunteer to participate in the interview. The researcher obtained the impression—although there is no certainty about it—that the sample of students who volunteered were probably some of the better physics students. The interviews needed to be voluntary, thus the researcher decided to use the convenience sample which was available. The researcher did obtain interviews with students of both genders, and a couple of different ethnicities—although one ethnicity was definitely more highly represented than any others among the students who volunteered to do the interview. Even though the interviews were based upon purely a convenience sample, the information they contain should provide more detailed information about the students' attitudinal views concerning physics, the students' self-efficacy views concerning physics, and the students' reasons for majoring (or not majoring) in physics. The interviews should also provide more detail about the specific views of physics students who attend university at the University of Mississippi.

The researcher also gave a different survey form, titled *Mississippi Physics Education: Instructor Survey Form*, to several physicists (physics instructors or research physicists). This survey form was a little different than the one given to the students, but there were some of the same questions on the form (so that some comparisons could be made between the views of the physicists and the views of the physics students). However, there were also some different questions which were more specifically directed to the physicists. Although the researcher had originally planned to have no short-answer portion on the physics instructor survey form (due to the fact that he planned to conduct detailed interviews with the physicists), the researcher did end up ultimately including 3 short answer questions on the instructor survey form which he gave to the physicists. The written answers of the physicists were transcribed by the researcher and analyzed, in terms of common themes. The physics instructor survey form also included a section for demographic information and a section with 9 multiple-choice questions. The researcher compiled these answers; percentages were then calculated by the researcher for the answers given to each of the multiple-choice questions. The researcher hopes the descriptive statistics calculated from this survey data will provide useful information concerning the views of a group of physicists who work or once worked in Mississippi.

All of the physicists, who were surveyed or interviewed, work or once worked at a university in the state of Mississippi. The great majority of them were from the University of Mississippi. However, there were also two physicists from Mississippi State University and one physicist from the University of Southern Mississippi who participated in this research project. The researcher also conducted approximately 10-minute, audio-recorded interviews with most of the physicists who were given the surveys. In most cases, the surveys were given to the physicist at the time of the audio-recorded interview. Some of the physicists completed the survey form at that time, and some of them sent it to the researcher through the mail at a later time. In other cases, the researcher picked up the completed survey form from the physicist's office at a later time. However, there were cases in which the physicist completed a survey form, but was not interviewed; in these cases, the physicist sent the survey form to the researcher through the mail. The researcher also sent out one survey form to a physicist via mail. Ultimately, the researcher obtained 16 completed physics survey forms from physicists who worked or once worked in Mississippi (at public, state universities in Mississippi).

The researcher tried, to a very high degree, to preserve the anonymity of the physicists as much as possible. Their names were not included in this project. Although the researcher does know some of the identities of many of the physicists who turned in completed survey forms, the forms did not have names on them—and the researcher generally placed the completed survey forms randomly in a large envelope in an attempt to preserve the anonymity of the physicists' answers from even the researcher. And, since some of the completed survey forms were sent back to the researcher via mail (and at least in some cases had no return-address names on the envelope), the researcher does not (with complete certainty) know the identities, in all of the cases, of which physicists turned in completed survey forms and which did not; however, the researcher does know, in many cases, whether or not a certain physicist turned in a completed survey form. (Also, it must be mentioned that although the researcher endeavored to obtain a high degree of anonymity, complete anonymity of the 16 physicists' survey forms was impossible to achieve since the researcher himself—having been a graduate student and a Teaching Assistant in the UM physics department for several years—was familiar with some of the professors' demographic details such as their race, gender, and in some cases other details such as where they attended college or which country they are from.) The researcher did, nevertheless, endeavor to preserve a high degree of anonymity of the physicists who turned in surveys (or participated in interviews). In total, the researcher obtained 16 completed survey forms from physicists who work or once worked at universities in the state of Mississippi.

As mentioned earlier, the researcher conducted audio-recorded interviews with several physicists who worked (or once worked) in the state of Mississippi. Overall, 17 total physicists (physics professors or research physicists) were interviewed. Of the 17 physicists, 5 were classified as "native-Mississippians." The other 12 physicists, although not classified as "native-Mississippians," do work (or have worked in the past) in the state of Mississippi as physicists; more specifically, this sample of 12 physicists all work presently (or worked previously) at the University of Mississippi. These 12 University of Mississippi physics professors (or research physicists) were interviewed according to the basic questions on the interview form titled, *Qualitative Survey Form (Interview with Physics Professors)* (see Appendix C).

The researcher used this form as a general guideline to follow when conducting the interview, but at times (during the flow of the interview) some extra questions were asked or some questions were omitted. The researcher hoped that these audio-recorded interviews with professional physicists, who work (or previously worked) in Mississippi, would provide more information about possible solutions to the problems faced by Mississippi physics students. The researcher also wished to record their views concerning physics education in Mississippi. The researcher wanted to record their opinions on what must be done, at the secondary level, to produce students who have the background necessary for success in physics at the general collegiate level and at the higher theoretical levels. The sample of the 12 University of Mississippi physicists was a convenience sample—the main requirements being that the physicist was a professional physicist who worked at a university in the state of Mississippi, and that the professional physicist agreed to participate in the interview. The transcriptions of these interviews were qualitatively analyzed by the researcher who categorized the main answers into common themes.

To begin the interview process, the researcher first asked each physicist for permission to conduct the interview; then an appointment was made. Generally speaking, the researcher would go to the physicist's office—or to a private room somewhere on campus—and conduct the interview. These audio-recorded interviews were designed to be approximately 10 minutes long; however, some of them were a little less than ten minutes; in other cases, the interviews turned out to be greater than 10 minutes. The researcher generally tried to ask the questions which were on the interview form, but the researcher also wanted to be flexible and let the physicists respond rather freely, without being interrupted much. Plus, at times, the researcher asked other relevant and interesting questions which arose, even though they were not on the interview form. At other times, the researcher, in the process of conducting the interview, skipped or omitted some of the questions which he had intended to ask. However, as a general rule, the researcher tried to follow the basic outline of the interview form when asking questions, while at the same time letting the interview flow naturally like a conversation—so that sometimes extra questions were asked, and at other times, certain questions were overlooked or omitted during the interview process. Overall, most of the physicists were asked the same general set of questions (give or take perhaps a question or two). One can observe the full transcripts of the interviews (see Appendix E) if one wishes to see more precisely the wording of the questions which were asked to each physicist.

As mentioned earlier, a total of 17 physics professors were interviewed. Twelve of the 17 professors were a convenience sample of University of Mississippi physics professors (or research physicists) who agreed to participate in the interview. The other five physicists (5 of the 17) who were interviewed were classified as "native-Mississippi" physicists, and they were also a convenience sample. Other than one slight exception for one of the physicists who moved to Mississippi as an infant of a few months old, these 5 "native Mississippi" physicists were born and educated in Mississippi; and they all had professional careers as physicists (as physics professors or physics researchers); at one time or another, they have all worked (or in some cases, still work) as professional physicists in the state of Mississippi. When these 5 "native Mississippian" physicists were interviewed, a slightly different interview form was used. This interview form was titled, *Qualitative Survey Form (Interview with Successful Mississippi Physicists)* (see Appendix C). This form was designed to more precisely address the topic of "Mississippi physics" and the experiences of professional, native-Mississippian physicists in the field of physics.

The researcher hoped to record the path that these native-Mississippian physicists took in order to achieve success at the highest levels of physics. The researcher wanted to record information about the success stories of these native Mississippians who have succeeded in the field of physics. The researcher wanted to explore the views of these native Mississippian physicists about what should be done to improve physics education in Mississippi. These interviews were also recorded, analyzed, and transcribed. The transcripts were qualitatively analyzed by categorizing the main interview answers into themes. The full transcripts of the interviews are included in Appendix E.

The interviews with the native-Mississippian physics professors were collected in a similar manner to how the interviews for the other physicists were collected. First, the researcher contacted the physicists and asked permission to conduct an interview; then an appointment time was set for the interview. The interviews were conducted in the physicist's office or in a private room on campus. In some of these cases, the researcher had to drive to Mississippi universities (other than Univ. of Mississippi) in order to interview physicists who could be classified as native-Mississippian physicists. Some of these physicists were retired physics professors/researchers, and some were still working. Overall, the sample was a convenience sample, because the researcher had a rather difficult time finding professional physicists who could be classified as native-Mississippian physicists; hence, those native-Mississippian physicists who agreed to participate in the interviews were the ones who were interviewed.

Once the researcher determined that a certain professional physicist could be classified as a native-Mississippian physicist, the researcher generally tried to schedule an interview appointment. The original goal for the research project was to interview 5 native-Mississippian physicists. Hence, the researcher did not continue to search for native-Mississippian physicists to interview once the original goal of five physicists had been reached.

Summary of Data Analysis Process

After the researcher had obtained the necessary data, the researcher tried to synthesize the qualitative and quantitative results into a comprehensible whole. This required much time—and the research process continued over many years. The greatest portion of the research was done during the summers when the researcher could spend time and energy on the project. It was important that the researcher endeavor to keep the data as secure as possible, so that no data would be lost during the extended research process. While working on the dissertation, the researcher saved the data on various softcopy files (such as on the computer hard-drive or on a removable flash drive). The researcher also kept the hardcopies of all the survey forms which were obtained from students and from the physicists. Generally, these hardcopy survey forms were stored in secure plastic boxes; the forms were carefully labeled so that they would not be mixed-up. Even though the hardcopy survey forms did not have names on them, the researcher later numbered them. This was done so that that each form could be meticulously kept up with. The audio files were recorded on two separate audio-recording devices during the interview process. This way, if one of the devices malfunctioned, the researcher would have a back-up file. Once the researcher had endeavored to store the data securely, the data analysis process could more safely be done.

The researcher analyzed the quantitative data provided by the various graduate schools by calculating descriptive statistics in order to find the percentage of physics graduate degrees that went to in-state residents. In some of these cases, the graduate schools provided the numbers. However, the percentages usually had to be tabulated by the researcher. The difficulty of these tabulations depended on the way the data was arranged as it was sent from each graduate school.

The researcher also calculated descriptive statistics (with the data from the University of Mississippi graduate school) concerning eight different majors, and the percentage of the graduate degrees (in these majors) which went to in-state residents. This process was rather tedious, because the researcher had to go through large lists of students who had received graduate degrees for each year. Then, the researcher had to count up how many of these students were classified as "in-state" and how many were classified as "out-of-state."   This had to be done for a period which spanned from the Fall 2003 semester until the Full Summer 2012 semester—and it had to be done for eight different majors. So, although the quantitative statistics were easily calculated, the numerical tabulation process (a counting process which required a visual search through stacks of paper) was very tedious and time-consuming. Data tablets were kept by the researcher. These show the record of the tabulation process. Once the numbers were tabulated, the percentages could be easily calculated with a hand-held calculator.

The researcher also calculated descriptive statistics on the demographic data and the multiple-choice data from the student survey form. During the process of calculating the descriptive statistics for the survey forms, the researcher counted up the numbers of students or physicists who had chosen each answer for each respective question. Then, once the researcher had counted up the number of students or physicists who had chosen each answer choice for that question, the researcher calculated the various percentages. The researcher kept several data tablets which show many of the tabulations for the descriptive statics for each of the various samples which were analyzed. Since the tabulations were carefully performed by hand, this was a very tedious and time-consuming part of the research.

The fact that the analysis was performed for several different samples (such as A-students, B-students, Asian students, Pre-med students, females, males, and so forth) meant that the whole process had to be repeated for many different samples—and all of this was carefully done by hand by the researcher in the tabulation notebooks. The final results of these tabulations (i.e. the descriptive statistics) are shown, for the most part, in the data tables in the Appendix.

Although the researcher did not perform specific quantitative tests for internal reliability of the survey forms, some of the questions on the survey form could possibly be tested for this since they are similar (such that one would assume, for reliability purposes, that they would have similar answers).

In order to check for problems with the validity of the student survey form, the researcher provided the form (during the dissertation research proposal process) to at least four professors at the University of Mississippi; to be more specific, they were given access to the form because it was part of the dissertation proposal. These four professors teach (or once taught) in the fields of science education, physics, or educational research; these four professors were the original four dissertation committee members. During the dissertation proposal process, they were also given access to all of the other forms (or instruments) which were used for the surveys and interviews of the students and professors; thus they had the opportunity to see the wording on the forms, and to make suggestions for corrections to the forms.

In the process of the dissertation research, the researcher noticed a slight error with one of the demographic questions on the instructor survey form. Thus, some of the physicists (who were surveyed) were given the corrected form, which had a very slight change to the wording of one demographic question. In an effort to make sure that the instructor survey form was not confusing or "technically wrong" (leading to wrong information), the researcher slightly altered the wording of that question. The question was a demographic question, and the incorrect wording stated, "If you are a U.S. citizen, please list the state you were born in." This question could cause confusion, because it did not take into account that some of the physicists (although originally born in foreign countries) might now be U.S. citizens; thus, in such cases, they would not have been born in a U.S. state—and hence, the question could have been confusing to them or could have produced possibly wrong information. Thus, the researcher slightly adjusted the wording of that one demographic question so that the confusion would not arise. The reworded question stated, "If you were born in the USA, please list the state you were born in." And, this slight change only affected that one question. And, by the way the answers were written, the researcher does not think it changed anything related to the quantitative descriptive statistics which were tabulated for the 16 professors who completed the survey form.

Also, the University of Mississippi shifted the student-email accounts to a new address not long before—or maybe during—the time this research was first begun. The researcher had the old email contact address listed on at the bottom of some of the instructor survey forms; but, at some point, the researcher updated some of the instructor survey forms with the new, corrected contact e-mail address. Other than those two small necessary changes on the instructor survey form, the four dissertation committee members (during the research proposal process) had access to all the survey forms and interview forms which were used for this research project.

The researcher originally had tentatively planned, if possible, to conduct correlation statistics tests between certain multiple-choice question responses on the student survey form in order to determine if certain responses correlated with other responses. However, due to the wide scope of the study and the time restraints involved, the researcher did not perform any quantitative correlation statistics on the data. However, quantitative statistics in the form descriptive statistics were calculated on the multiple-choice question responses and on the data which was obtained from the graduate schools.

The researcher transcribed the recorded interviews with the students and professors, and searched for common themes among the answers.   Once having found themes among the answers, the researcher endeavored to place these into tables in an attempt to find the most commonly mentioned themes. The researcher also kept data tablets for this part of the research. The data tablets show how the researcher endeavored to be as consistent and careful as possible, under the conditions, to separate the items from the interviews (or written answers) into themes. This particular part of the research, dealing with categorizing the interview transcript answers into themes, was probably the most tedious part of the research. It was extremely time-consuming and required great mental concentration. At times, it was very hard to quantify the interview transcripts into themes because the wording of the answers was, at times, nebulous and hard to fully quantify. At other times, a student or an instructor might give an answer which was totally separate from any other answers, so that it could not be easily categorized into any "common theme" which was shared by anyone else. Usually, in these cases, a new theme category was generated—even though only one student or professor mentioned that particular idea (or theme). In general, when analyzing the interview transcripts, the researcher first tried to select the "main answer" which the student or researcher gave to the question which was being asked in the interview. The researcher endeavored to record these "main answers" in a systematic way. Then, once having selected the "main answer," the researcher could more easily omit any superfluous items which occurred in the interview—such as "small talk," redundant statements, extra-long additions to the "main answer," or things which might not apply to the particular question. Then, the researcher more carefully tried to categorize these "main answers" into common themes. The results of this process of are shown in the theme tables which can be found in Appendix E. The selected "main answers" are shown in Appendix E. The full transcripts of the interviews are also included (see Appendix E) so that the reader can see the full context of the questions and answers from which the various "main answers" and themes were chosen.

The researcher also transcribed the students' and physicists' written responses to the "short-answer" survey questions. The answers (i.e. the written responses of the students and physicists to the short-answer questions) which the students and physicists wrote on the survey forms were typed into a word processing file by the researcher; these typed responses are also included in this dissertation (see Appendix D). Once the written responses had been typed, the researcher tried to categorize these responses into pertinent "themes" or "broad categories," and to include some descriptive statistics with this material in an attempt to somewhat quantify the written answers of the students and physicists. This was done by carefully reviewing the typed print-outs of the students' and physicists' written responses to the short-answer questions. Then, various portions of the typed text were circled and labeled—according to the main idea or theme which was addressed by that portion of the text (i.e. that portion of the student's or the physicist's answer). Often, two or three trials (or more) were performed by the researcher before he finally felt somewhat satisfied that the written responses had been properly categorized into the proper themes for that particular question. As a last step, the researcher put the results of this "thematic analysis" into data tables so that other researchers (or readers) can get a basic idea of the main answers (or responses) that were given by the students and physicists to the short-answer questions on the survey form.

Research Design

This dissertation research was a mixed-methods study which employed both quantitative and qualitative research methods. Although the study was a mixed-methods research study, it was more heavily weighted toward the qualitative aspect since there are multiple audio-interviews which needed to be transcribed. This process required much time and effort; the researcher painstakingly played audio-recordings over and over, in some cases, in an attempt to get the exact wording correct. (In a few cases, the researcher—in order to try to get the transcript wording to be as accurate as possible—

replayed certain confusing portions of the audio recordings to some of the physicists who had been interviewed.)

In the process of this dissertation research, the researcher performed (a) quantitative descriptive statistics about the data from the graduate schools; (b) quantitative descriptive statistics about the demographic and multiple-choice data from the student survey forms; (c) quantitative descriptive statistics about the multiple-choice data from the instructor survey forms; (d) qualitative analysis (via common themes) of the short-answer written information from the student survey forms and instructor survey forms; and (e) qualitative analysis of the interviews with students, physics instructors, and native-Mississippian physicists by analyzing the interview transcripts for common themes.

The quantitative portion of this research study involved the calculation of descriptive statistics on data that was gathered via cluster sampling; however, there was also an element of convenience sampling in the sample of physicists due to the fact that the researcher surveyed and interviewed physicists who were conveniently available and willing to participate in the study . The qualitative portion of this research could be classified as an emergent-design study, since the researcher wanted to be flexible to pursue relevant topics of inquiry which might arise during the interview process.

Sample (of Students and Physicists) Involved in the Research

- The student survey forms (titled *Mississippi Physics Education: Student Survey Form*) were given to physics lab students (N_{Total} = 113) who were enrolled in Engineering Physics II labs [i.e. calculus-based physics labs] or General Physics

II labs [also called “pre-med physics” labs or “trig-based physics” labs] at the University of Mississippi. The survey was given to the students at the beginning of their lab class; the researcher visited five separate lab classes in order to conduct the surveys. The researcher only counted survey forms that were completely filled out or filled out to a fairly large degree (or proportion). The sample sizes of the completed survey forms (or almost completed survey forms) from the five labs were as follows: $N_1 = 24$ (General Physics II lab surveyed on April 24, 2013); $N_2 = 25$ (Engineering Physics II lab surveyed on April 24, 2013); $N_3 = 13$ (Engineering Physics II lab surveyed on July 24, 2012); $N_4 = 25$ (General Physics II lab surveyed on July 24, 2012); $N_5 = 26$ (Engineering Physics II lab surveyed on April 24, 2013). Adding all the individual labs together, the researcher obtained a total of 113 completed student survey forms ($N_{Total} = 113$). The sampling technique (for administering the student surveys) was cluster sampling since by giving the survey forms to 5 lab classes, the researcher obtained 113 completed (or almost completed) physics student survey forms from the larger population of physics students at the University of Mississippi.

- The physics instructor survey forms (titled *Mississippi Physics Education: Instructor Survey Form*) were given to physicists (physics professors or research physicists). The large majority of the physicists worked (or once worked) at the University of Mississippi (where the researcher was enrolled in graduate school). However, this research project also included two physicists from Mississippi State University, and one physicist from the University of Southern Mississippi. The researcher obtained a total of 16 ($N_{PI} = 16$) completed (or almost completed) instructor survey forms from the slightly larger group of physicists who were involved in this research project—and since the forms were meant to be anonymous, the researcher does not know the exhaustive list of the names of which physicists submitted completed survey forms. The sample of physicists was mainly chosen by convenience in the sense that the researcher gave the forms to those professors who were available and willing to conduct interviews. However, the researcher also gave (and received back) some forms to some physicists who did not conduct interviews. The sample also had elements of a cluster sample, because the 16 physicists who turned in survey forms represented a smaller cluster out of the much larger group of physicists who work (or once worked) at universities in the state of Mississippi.

- A total of 10 students (N = 10) were selected (by convenience) to participate in approximately 5-minute interviews concerning their views of physics. These students were selected via convenience sampling since the researcher, during the survey process in the labs, asked for student volunteers to conduct interviews afterward; hence only those students who volunteered to come by after the lab class to be interviewed were included in sample. The researcher attempted, in small ways, to encourage (or find) a diversity of genders and ethnicities within the sample; so this could possibly be viewed as a type of stratified sampling. Both genders were represented in the sample of students who were interviewed; however, there was not a large variety of different ethnicities represented in the convenience sample of students who volunteered to stay for the interviews.

- Twelve (N = 12) University of Mississippi physicists (physics professors or research physicists) participated in audio-recorded interviews concerning their views about physics and about how Mississippians can improve physics education. The twelve physicists in this particular sample were not classified among the sample of native-Mississippians, because as far as the researcher is aware, they were not born and educated in the state of Mississippi. The sampling technique for choosing the 12 physicists for the interviews was based mainly on convenience since only those instructors who were available and willing to be interviewed were interviewed. However, the sample was also a cluster sample taken from the larger population of physics instructors at the University of Mississippi.
- Separate audio-recorded interviews were also conducted with five native-Mississippian physicists (N=5) who were selected mainly by the convenience of their availability and willingness to conduct the interview. The main requirement which was used, when selecting them, was that they needed to have been born in Mississippi and received much of their education in Mississippi, and that they needed to have worked successfully as a physicist—and the researcher ultimately decided to let the fact that that they had worked as a university physics professor be the main requirement for their being classified as "successful physicist." In one of the 5 cases, the physicist was not actually born in Mississippi, but moved to Mississippi as an infant. Some of the physicists were retired professors, and some of them were still working as professors. In the sample of the five native-Mississippian physicists, there were two physicists who worked (or once worked)

at the University of Mississippi, two physicists who worked (or once worked) at Mississippi State University, and one physicist who worked (or once worked) at the University of Southern Mississippi.

Conclusion Statements for Methodology

Now that data from this research study has been gathered and analyzed over a period of several years, it is hoped that the results will be useful to physicists or other officials who wish to better understand physics education in the state of Mississippi (or in any other state or country). The results were quite expansive due to the extremely broad nature of this mixed-methods study. Many of the data tables containing the quantitative results, which show the descriptive statistics which were tabulated for the data from the graduate schools and for the data from the survey answers, are shown in Appendix D. The typed, written answers (to the short-answer survey questions) of the students and professors are also included in Appendix D in order to remain true to the logical order of the survey questions and to keep the survey data together. The written responses of the students and physicists (i.e. professors) were also broken into themes (or broad categories) and analyzed. Some descriptive statistics were calculated in regard to these themes. These theme tables for the written responses are shown in Appendix D.

The qualitative results include the full interview transcripts with the 17 physicists and 10 physics students (see Appendix E). The main answers obtained from the interview transcripts, separated out question-by-question in accordance with the interview forms, are also included (see Appendix E); the data tables which show the main answers in terms of "most commonly mentioned themes" are also included in Appendix E.

The next chapter contains the summary results which are embedded within the "discussion of results" section. In this portion of the dissertation, the original quantitative and qualitative results are condensed further, and are analyzed with more detail in order to distill important information—especially in regard to the research questions.

CHAPTER 4: DISCUSSION OF RESULTS (WITH SUMMARY TABLES)

General Overview of Discussion of Results

One of the main results of this research project was the creation of a strong foundation of data documentation—from many different areas—concerning physics education in Mississippi. However, there was arguably too large of a collection of data to simply be included in a results chapter. Thus, the vast majority of the data (such as the data from the graduate schools, the survey results, the interview transcripts, and the written responses) are included in Appendix D and Appendix E.

In this chapter, the researcher will discuss the main results that were obtained from the large collection of data. The discussion of the results will mainly be organized around the original 13 research questions. However, some other general observations gathered from the results will also be discussed.

The survey results (see Table 1-Table 368 in Appendix D) and the transcripts of interviews with the professors and students (see Appendix E) are important. They should be interesting to people today and to people many years into the future. However, since there was such a large collection of data tables and transcript data, the decision was made to place this large collection of information in the Appendix.

This research project, having been so broad and all-encompassing, could serve as a type of "evaluation" of educational aspects of physics in Mississippi, especially at the

University of Mississippi. And really, it only provides a starting point for an educationally oriented evaluation of physics in Mississippi. However, when the researcher first started working on this research project, it seemed to the researcher that there was very little evidence or documentation at all about Mississippi physics (especially as it related to educational aspects of graduate-level physics). In the process of the literature review, the researcher could find very little educationally related data concerning Mississippi physics—at least, not in the sample of sources where the researcher looked. The researcher, at times, felt that he was working alone in an unexplored subject. This made the work very interesting, but it also meant—at least, at the time of the original literature review—that there were few sources to build upon when attempting to study Mississippi physics and the views of physics professors and physics students in the state. To the knowledge of the researcher, there was no research that was available, at the time, which compared (descriptively) the various percentages of resident vs. non-resident degree recipients from certain majors at the graduate school of the University of Mississippi. Intuition alone might have guided one to believe that certain majors contained more "in-state" residents. However, this research project shows some descriptive statistics which should help solidify our knowledge of how many "in-state" residents are graduating from our graduate school programs—at least, for the time span which this research project covered. Perhaps this research will help provide a much firmer foundation upon which future researchers can build.

Plus, this research can serve as historical documentation of the views of Mississippi physics professors and Mississippi physics students. The survey data and the descriptive statistics which were tabulated (see Appendix D), should provide researchers with deeper insight into the views of physicists and students in Mississippi at the time when that portion of the research was conducted, which was mainly in 2012 and 2013. The data gathered from this research project—such as the interview transcripts and the survey data—should also be of interest to many other places in the world. Also, the data which was compiled concerning graduate school degree recipients (in terms of "in-state" resident vs. "total population" of graduate degree recipients) should be uniquely interesting to those involved in higher education. In the remaining portion of this chapter, the researcher will discuss many of the main results of the large collection of data which was gathered in this research project.

Research Questions Re-visited in the Light of the Results of this Research

One of the main focus-points and purposes of this research project was to attempt to answer the research questions. Thus, the researcher will discuss the research questions and how the results of the research might provide answers to the questions.

Research question #1.

Since the Fall semester of 2003, what percentage of the physics graduate degree recipients at the University of Mississippi were classified as Mississippi residents?

The researcher obtained data from the graduate school at the University of Mississippi for the Fall semester of 2003 up through the Full Summer semester of 2012. The complete descriptive statistics for this data, for each academic year, are shown in the results tables.

The researcher found that from the Fall 2003 semester up through the Full Summer semester of 2012, a total of 16 M.A. (Master of Arts) degrees in physics were awarded at the University of Mississippi; and of the 16 students who received these M.A. degrees in physics, 5 were classified as Mississippi residents. This means that, according to the records provided by the University of Mississippi Graduate School, 31.3% (or 5 of 16) of the M.A. degrees in physics at the University of Mississippi were awarded to students who were classified as Mississippi residents.

The researcher found that from the Fall 2003 semester up through the Full Summer semester of 2012, a total of 19 M.S. (Master of Science) degrees in physics were awarded at the University of Mississippi; and of the 19 students who received these M.S. degrees in physics, 10 were classified as Mississippi residents. This means that, according to the records provided by the University of Mississippi Graduate School, 52.6% (or 10 of 19) of the M.S. degrees in physics at the University of Mississippi were awarded to students who were classified as Mississippi residents.

The researcher found that from the Fall 2003 semester up through the Full Summer semester of 2012, a total of 18 PhD (Doctor of Philosophy) degrees in physics were awarded at the University of Mississippi; and of the 18 students who received these PhD degrees in physics, 7 were classified as Mississippi residents. This means that, according to the records provided by the University of Mississippi Graduate School, 38.9% (or 7 of 18) of the PhD degrees in physics at the University of Mississippi were awarded to students who were classified as Mississippi residents.

If one compiles the data from the three types of physics degrees (M.A., M.S., and PhD) to obtain a sum total, one finds that from the Fall semester of 2003 up through the

Full Summer semester of 2012, a total of 53 graduate degrees in physics were awarded at the University of Mississippi; and of these 53 graduate degrees in physics, 22 of the degrees were awarded to students who were classified as Mississippi residents. This means that according to the records provided by the University of Mississippi graduate school, 41.5 % (or 22 of 53) graduate degrees in physics were awarded to students who were classified as Mississippi residents. And, when interpreting this, one must understand that this data includes many cases of students who obtained both a Master's and a PhD degree. In that case—in other words, if a student obtained both a Master's and a PhD degree between the time period of Fall 2003 through Full Summer 2012—that one student would account for two of the 53 total graduate degrees awarded. So, the fact that 22 total physics graduate degrees (M.A., M.S., and PhD) were awarded to students who were classified as Mississippi residents does not mean that there were 22 different students in the sample—for some students received two of the 22 total degrees since they obtained both a Master's and a PhD during that time period. And, the researcher also discovered other reasons that must be considered, if one wants to truly get a better picture of how many native Mississippians are receiving graduate degrees.

During the early stages of the dissertation proposal research, the researcher confirmed that some of the students who were classified in the graduate school degree records as "Mississippi residents" were not actually native Mississippians, in the traditional sense of having been born, raised, and educated in Mississippi. Hence, not all of the students in the sample of 22 degrees which were awarded to students classified as Mississippi residents were actually born, educated, or raised in the state of Mississippi. The researcher confirmed, by personal communication with a few of the graduate students, that some of these graduate students who were classified officially as "Mississippi residents" were not actually native Mississippians, in the sense of having been born, raised, and educated in the state.

In the process of this research project, the researcher was able to see the lists of the students who received graduate physics degrees during the time period which the graduate school records covered—and the researcher is very familiar with many of the physics graduate students. Indeed, the researcher has talked with many of the graduate students who received degrees during this time period (from Fall 2003 through Full Summer 2012), and the researcher knows many of them personally. And, after reviewing the lists and talking with some of the physics graduate students, the researcher can say that not all of the 22 graduate physics degrees which were awarded to students classified as "Mississippi residents" went to students who were actually born, raised, and educated in Mississippi.

The researcher says this not to disparage them or to fault these students for establishing residency when they moved to Mississippi. However, the researcher must mention these things in order to help others understand the truth that not all students who are classified as "Mississippi residents" are native Mississippians in the traditional sense of having been born, raised, and educated in Mississippi. Some of them have established Mississippi residence rather recently—for convenience reasons or for financial reasons, presumably.

The researcher did not try to verify, with absolute certainty, every single case in which a physics graduate degree recipient moved to the state and established Mississippi residence, but was not actually born, raised, or educated in Mississippi. That would have likely carried the researcher far outside of the scope of the research design. The researcher did not try to verify whether or not the opposite case occurred—in other words, whether or not any of the Univ. of Mississippi graduate physics students in the sample were born, raised, and educated in Mississippi but were classified as "out-of-state" students for some reason.

The researcher is not fully informed concerning all of the legal procedures for establishing residency in Mississippi; nor is the researcher fully aware of all the reasons why a student might choose to establish Mississippi residency status once moving here. However, it is clear that one must at least be aware of the issue if one wants to properly interpret the data of this research project—and if one wants to properly interpret the data from the University of Mississippi graduate school concerning residency status. And, generally speaking, it does not take much of a logical jump to wonder whether or not the data from many other graduate schools around the country and world might also need to be interpreted in the light of this phenomenon concerning "official residency status" vs. "native-born residency status" (i.e. residency status obtained due to having been born, raised, and educated in that particular state or country).

If the percentages of graduate degrees awarded to Mississippi residents are skewed due to the issue concerning out-of-state residents who moved to Mississippi and then established residency, one might guess that the same thing may happen in the other subject areas (other than physics). However, the researcher cannot say this with certainty. The researcher can only surmise that it is highly likely that the percentages measuring the number of graduate degree recipients who were classified as "Mississippi residents" in other subject areas would also need to be adjusted to lower values, if one really wanted a true measure of the percentage of graduate degrees which were awarded to native Mississippians in the traditional sense of having been born, raised, and educated in the state of Mississippi. Perhaps an entirely new research project could be designed by researchers to study exactly how many of the students classified as "in-state residents" are actually residents of that particular state, in the more traditional sense of having been born, raised, and educated there

Of course, it is important that universities seek to provide a high-quality education for all of their students, regardless of their residence status. Yet, it stands to reason that at least a certain percentage—and arguably, a fairly high percentage—of the public university students (and degree recipients) should come from the state which is helping to support and fund the university. The students who were born, raised, and educated in the state of Mississippi would probably be the most likely to stay in the state or return to the state in later years (due to family connections or other factors).

Also, it must be mentioned that some Mississippi natives might have attended other universities (such as out-of-state universities) to obtain graduate degrees in physics. This could be another possible explanation for the fact that there seemed to be a low number of Mississippi natives among the graduate degree recipients. It is a common practice for students to obtain a graduate degree from another institution other than the one from which they obtained their undergraduate degree. Thus, it could be possible that Mississippi natives who obtain physics degrees at the University of Mississippi might be attending other universities to obtain graduate degrees in physics. The researcher did not try to determine the number of Mississippi natives who go out of state to obtain graduate degrees in physics. The researcher does know that several of the "successful Mississippi-native physicists" who were interviewed did obtain graduate physics degrees from out-of-state universities.

In summary, according to the records provided by the University of Mississippi graduate school for the time period spanning the Fall of 2003 semester up through the Full Summer 2012 semester, 41.5 % (or 22 of 53) graduate degrees in physics were awarded to students who were officially classified as Mississippi residents. The percentage is even lower if one accounts for the fact that some students who were classified as "Mississippi residents" were not actually native Mississippians in the traditional sense of having been born, raised, and educated in Mississippi. There is evidence to suggest that some of the students obtained "Mississippi resident" status for convenience reasons, for financial reasons, or possibly for other reasons. The results of this portion of the research provide evidence to show that during the time span from the Fall of 2003 semester through the Full Summer 2012 semester, a majority of graduate physics degree recipients at the University of Mississippi were awarded to students who were not classified as residents of the state of Mississippi.

Research question #2.

Since the Fall semester of 2003, what percentage of the graduate degree recipients in other graduate degree programs (such as Chemistry, Math, History, English, Business, Accounting, Chemical Engineering, Electrical Engineering, and Mechanical Engineering) at the University of Mississippi were classified as Mississippi residents?

The researcher had originally planned to investigate the above nine graduate degree programs (along with Physics graduate degree program, as well). However, in the course of the research, the researcher realized that the University of Mississippi did not offer graduate degrees in the subjects of chemical engineering, electrical engineering, or mechanical engineering, even though bachelor's degrees were offered in these subjects. However, both the Master's degree and the Doctoral (PhD) degree were offered in the subject of "engineering science" at the University of Mississippi. The researcher confirmed this information (concerning the engineering degrees) by reviewing information published by the *Book of Majors (2013), 7th Edition* published by College Board (a not-for-profit organization). The researcher also saw evidence of this in the process of reviewing the data which was provided by the graduate school since there were no graduate degrees listed for chemical engineering, electrical engineering, or mechanical engineering in the data which was provided to the researcher. Thus, the researcher compiled the data for the graduate degrees in engineering science rather than for the graduate degrees in chemical engineering, electrical engineering, and mechanical engineering, as originally planned. However, all of the other majors which the researcher originally planned to investigate did offer graduate degrees at the University of Mississippi (although some of the names of the majors were slightly different than the researcher originally thought—such as occurred in the case of "Business Administration" replacing the researcher's original designation of the degree as "Business").

Ultimately, the researcher investigated the following eight graduate degree programs at the University of Mississippi in terms of determining the number and the percentage of their graduate degree recipients which were listed as Mississippi residents: (1) Chemistry, (2) Business Administration, (3) Accountancy, (4) Engineering Science, (5) History, (6) English, (7) Mathematics, and (8) Physics. The researcher compiled descriptive statistics for each year (starting from the Fall semester of 2003 up through the

Full Summer semester of 2012); these descriptive statistics, shown for each year, are displayed in the data tables (see Table 1-Table17 in Appendix D).

However, the researcher will now discuss the main results of this portion of the research, in terms of specifically answering the research question. The summary tables below summarize data from the data tables in the Quantitative Results section (Ch. 4), and help give a more concise answer to the research question concerning the percentage of graduate degree recipients who were classified as Mississippi residents in the various degree programs which were listed. For purposes of comparison, the researcher also included the results for the physics graduate degrees, also. The four summary tables are shown in Table 372, Table 373, Table 374, and Table 375 which follow:

(Note: Table 1-Table 368 are in Appendix D; Table 369-Table 371 are in Appendix E.)

Table 372

Summary Data for Eight Graduate Degree Programs at University of Mississippi (Fall 2003 through Full Summer 2012), Shown by Graduate Degree Type

Graduate Degree Program	Total Number of Master of Arts (M.A.) Degrees Awarded	% Mississippi Residents (for M.A. degrees awarded)	Total Number of Master of Science (M.S.) Degrees Awarded	% Mississippi Residents (for M.S. degrees awarded)	Total Number of PhD Degrees Awarded	% Mississippi Residents (for PhD degrees awarded)
Chemistry	NA	NA	18	44.4 %	25	24.0 %
Business Administration	NA	NA	NA	NA	76	35.5 %
Accountancy	NA	NA	NA	NA	21	57.1 %
Engineering Science	NA	NA	388	34.8 %	84	11.9 %
History	69	59.4 %	NA	NA	42	50.0 %
English	57	45.6 %	NA	NA	52	46.2 %
Mathematics	2	100.0 %	60	60.0 %	30	50.0 %
Physics	16	31.3 %	19	52.6 %	18	38.9 %

Note. In this chart, "NA" means “Not Applicable”. Generally, this means that the particular graduate degree program does not offer that particular degree type; or at least, it was not included in the data provided to the researcher for the time span between the Fall 2003 semester up through the Full Summer 2012 semester.

The table above shows the total number of M.A., M.S., and PhD degrees awarded (to all students) and the percentage of M.A., M.S., and PhD degrees awarded to

Mississippi residents by eight University of Mississippi graduate degree programs from Fall 2003 through Full Summer 2012. The table which follows shows the total number of MBA degrees awarded (to all students) and the percentage of MBA degrees awarded to Mississippi residents by the Business Administration graduate degree program at the University of Mississippi from Fall 2003 through Full Summer 2012.

Table 373

Summary Data for Master of Business Administration (MBA) Degrees at University of Mississippi (Fall 2003 through Full Summer 2012)

Graduate Degree Program	Total Number of Master of Business Administration (MBA) Degrees Awarded	% Mississippi Residents (for MBA degrees awarded)
Business Administration	480	62.3 %

The table which follows shows the total number of M Accy degrees awarded (to all students) and the percentage which were awarded to Mississippi Residents by the Business Administration program at UM (Fall 2003 through Full Summer 2012).

Table 374

Summary Data for Master of Accountancy (M Accy) Degrees at University of Mississippi (Fall 2003 through Full Summer 2012)

Graduate Degree Program	Total Number of Master of Accountancy (M Accy) Degrees Awarded	% Mississippi Residents (for M Accy degrees awarded)
Accountancy	510	75.1 %

The table which follows shows the compiled total of the graduate degrees (M Accy, MBA, M.A., M.S., DA, and PhD) which were awarded by the eight University of Mississippi graduate degree programs which were included in this study. The data in the table includes graduate school data from the Fall 2003 semester up through the Full Summer 2012 semester.

Table 375

Compiled Total of the Graduate Degrees (M Accy, MBA, M.A., M.S., DA and PhD) which were Awarded in Eight Different Graduate Degree Programs at University of Mississippi (Fall 2003 semester through Full Summer 2012 semester)

Graduate Degree Program	Total Number of Graduate Degrees Awarded	Total Number of Graduate Degrees Awarded (MS Residents)	% of Graduate Degrees Awarded to MS Residents
Chemistry	46	17	37.0 %
Business Administration	556	326	58.6 %
Accountancy	531	395	74.4 %
Engineering Science	472	145	30.7 %
History	111	62	55.9 %
English	109	50	45.9 %
Mathematics	92	53	57.6 %
Physics	53	22	41.5 %
GRAND TOTAL	**1970**	**1070**	**54.3 %**

Note. The above table does include the three Doctoral of Arts (DA) degrees which were awarded to three Mississippi residents. These three DA degrees were not included in the other tables (for the Chemistry Graduate Degree statistics) since they were not PhD degrees. However, they are included in this table. The two M.A. degrees in Math which were awarded to two Mississippi residents are also included in the above table.

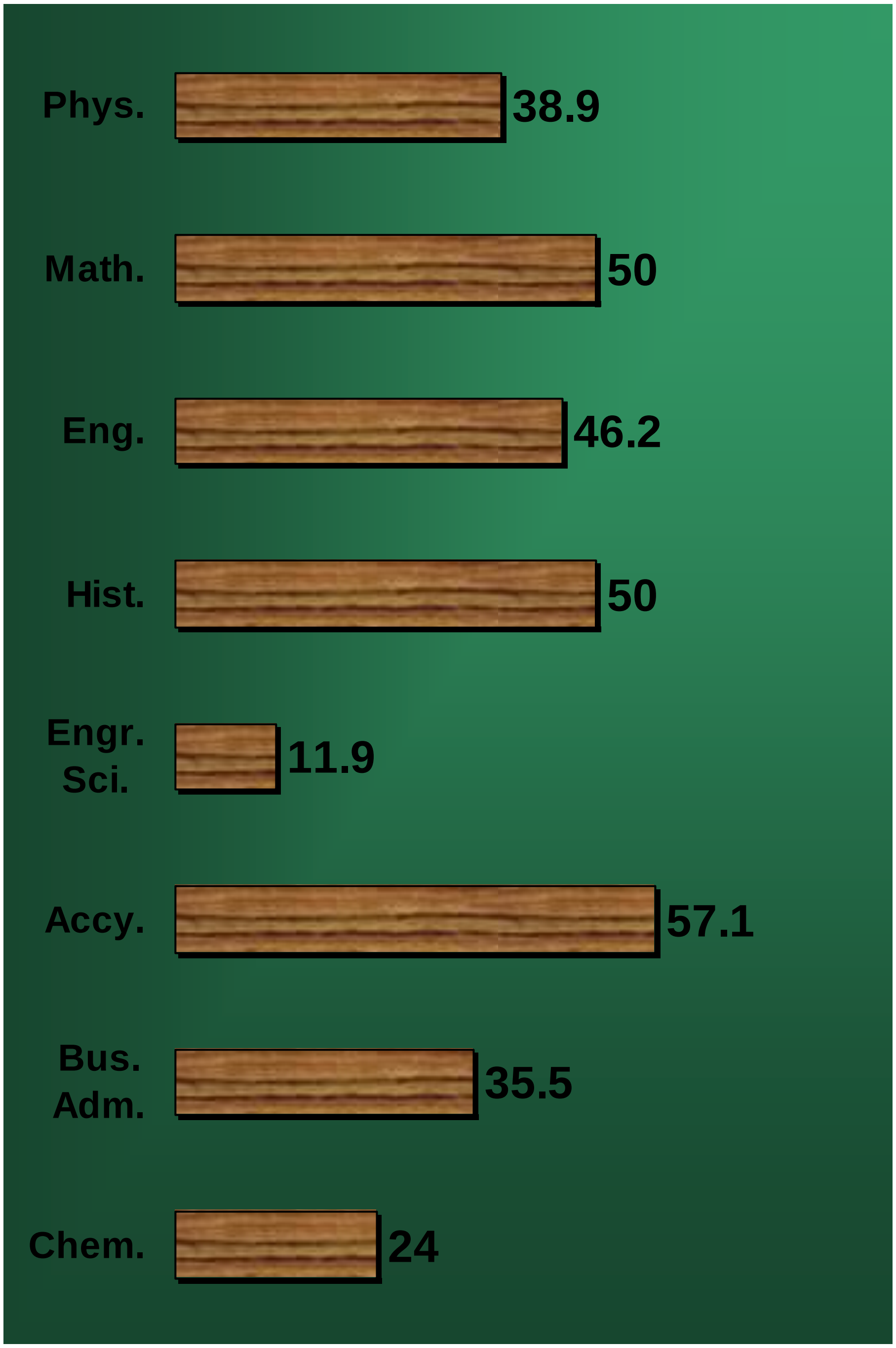

Figure 3. The chart above (for eight graduate degree programs at the University of Mississippi from Fall 2003 through Full Summer 2012) illustrates the percentage of PhD degrees which were awarded to students who were classified as Mississippi residents (according to the data provided by the University of Mississippi Graduate School). The eight graduate degree programs shown are Chemistry, Business Administration, Accountancy, Engineering Science, History, English, Mathematics, and Physics.

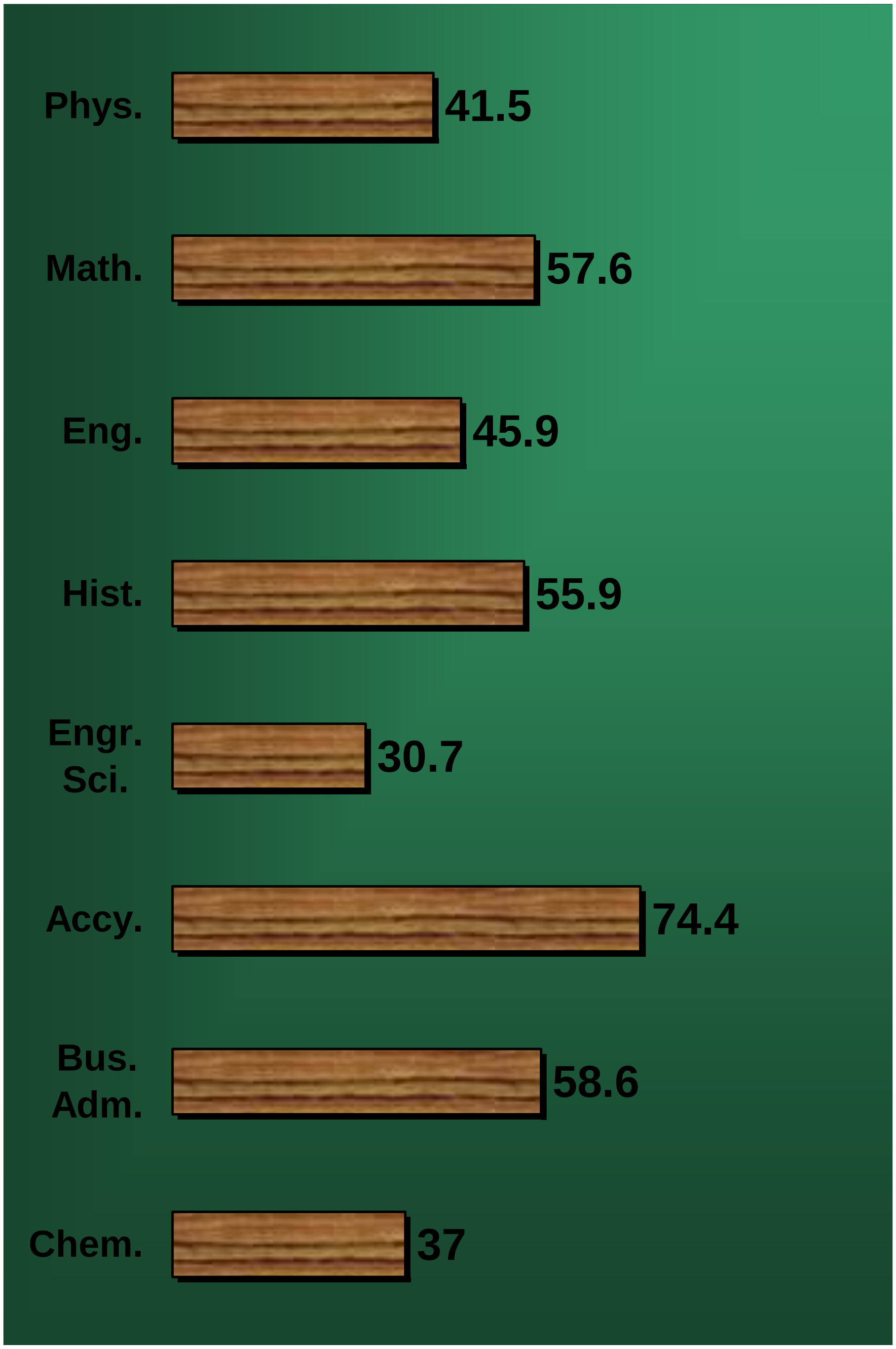

Figure 4. The chart above (for eight graduate degree programs at the University of Mississippi from Fall 2003 through Full Summer 2012) illustrates the percentage of total graduate degrees which were awarded to students who were classified as Mississippi residents (according to the data provided by the University of Mississippi Graduate School). The eight graduate degree programs shown are Chemistry, Business Administration, Accountancy, Engineering Science, History, English, Mathematics, and Physics. The graduate degrees represented in the compiled data were the M Accy, MBA, M.A., M.S., DA, and PhD degrees.

Upon observing the previous four summary tables (see Tables 372-375), one can make a few observations concerning the results for the eight degree programs which were investigated. The data (in Tables 372-375) is comprised of descriptive statistics. Thus, when making comparisons between the percentages shown in these tables, the researcher is speaking of the basic picture (or description) which has been painted by the descriptive statistics of the data which spanned a time period of almost nine years—from the Fall semester 2003 through the Full Summer Semester of 2012.

When beginning this research project, the researcher had expected the Physics graduate degree program to have a noticeably lower percentage of its graduate degrees being awarded to "in-state" students (i.e. Mississippi residents) when compared to most of the other graduate degree programs. Of course, this somewhat proved to be true—since physics, when compared to the other seven majors, had the third lowest percentage (of its graduate degrees going to in-state students). However, the difference, when compared to the other majors (i.e. degree programs), was not nearly as drastic as the researcher expected. Indeed, there were two graduate degree programs, Chemistry and Engineering Science, which showed even lower percentages (than the Physics graduate degree program) of their graduate degrees going to Mississippi residents.

Of course, if looked at in terms of the GRAND TOTAL for all of the eight graduate degree programs which were included in this research project, the physics percentage (41.5 %) of graduate degrees going to Mississippi residents was below the GRAND TOTAL percentage (54.3 %) of graduate degrees going to Mississippi residents (in the eight degree programs which were included in this research project). Yet, again, the researcher must mention that he is speaking in terms of "descriptive statistics", not rigorously proved statistical analysis of significance. But, over the nine year period, the percentage of graduate physics degrees awarded to in-state residents was a little lower than the average percentage (i.e. the percentage for the GRAND TOTAL) of graduate degrees awarded to in-state (i.e. Mississippi) residents by the entire group of eight degree programs.

With that said, the researcher must again mention that although the percentage of physics graduate degrees awarded to Mississippi residents was a little lower than the "group average" percentage (as seen in the percentage of the GRAND TOTAL), the difference was not nearly as drastic as the researcher had expected. For, although the researcher had expected the subjects of chemistry, math, and engineering (in this case, engineering science) to have similar values to physics, in terms of percentage of graduate degrees going to in-state students, the researcher did not expect these subjects' percentages (even descriptively speaking) to be lower than the percentage for physics—which was the case for the chemistry (37.0 %) and engineering science (30.7 %) graduate degrees.

The researcher was particularly surprised by low the percentage (11.9 %) of graduate PhD degrees which were awarded to Mississippi residents in the subject of engineering science. Of course, it is well-known that engineering requires a large amount of heavy science and heavy math. However, the researcher just did not expect the percentage, descriptively speaking, to be so much lower than the percentage (38.9 %) shown by physics (in terms of graduate PhD degrees awarded to Mississippi residents). One possible explanation, in the opinion of the researcher, is the fact that the largest (and arguably most well-known) engineering school in the state of Mississippi is at

Mississippi State University. Perhaps this draws a larger proportion than normal of the Mississippi residents who are interested in engineering, and who would be more aware of the fact that Mississippi State is known as the “engineering school” in the state of Mississippi. Perhaps the Engineering Science graduate degree program must find more students from outside of the state due to a low number of Mississippi residents who apply. However, the researcher cannot say for certain about this conjecture. There may be an entirely other explanation.

Of course, the researcher is very aware that engineering is a heavy-math, heavy-science subject—and thus might experience lower numbers of Mississippians entering the graduate program in that subject than some other subjects   The researcher just did not expect Engineering Science to have such a visibly lower percentage (11.9 %) than Physics (38.9%), in terms of graduate PhD degrees being awarded to Mississippi residents. The Chemistry graduate degree program also showed a noticeably low percentage (24.0%) of graduate PhD degrees being awarded to Mississippi residents.

This brings up another general pattern that the researcher observed from the descriptive statistics: that in general, the PhD degrees were awarded in lower percentages to Mississippi residents than were the Master’s degrees. This was not true in every single case for the eight degree programs, but it did seem to be the general pattern shown by the descriptive statistics of the eight degree programs. Thus, either Mississippians are not as successful in the PhD programs or they are just not applying to the programs in as high of numbers. Perhaps the Mississippians are choosing to attend PhD graduate degree programs at other universities. Another possible explanation is that Mississippi residents who do apply for the PhD programs might have resumes (i.e. test scores and such) that are less competitive—or might not meet some other admission criteria as successfully as the out-of-state applicants. Another alternative explanation is that the PhD programs might just have many more out-of-state applicants for PhD programs which might increase the competition. The possibility that Mississippi residents who apply for the graduate programs might have less competitive applications (if this is true) than some of the other applicants might, in part, be due to the issue that at least one (if not more) of the professors mentioned: the pure effect of population. Mississippi has a relatively small population when compared to many other states (or countries). In larger populations, just by the blind statistics of numbers, one would expect, if all other factors were equal, to have a larger number of excellent students. And, many of these students might be competing with a much smaller pool of Mississippi residents who are applying for graduate school.

There are a multitude of possibilities and conjectures which could be explored concerning the issue of why there are, in general, lower percentages of Mississippi residents among the PhD degree recipients than among the Master's degree recipients. The researcher cannot say for sure about many of these conjectures, because the data-gathering necessary to further explore such ideas was not part of the design of this research project. The researcher can only say that the data which was obtained gives evidence, descriptively speaking, that at least for these eight graduate programs, the general pattern is for the PhD programs to have a lower percentage of the degrees going to Mississippi residents than the Master's degree programs have.

Another expected outcome, in the mind of the researcher at the very start of this research project, was that the researcher expected the "non-heavy-math" and "non-heavy-science" programs, such as Accountancy, Business Administration, English, and History to show a markedly higher percentage of their graduate degrees being awarded to in-state residents (i.e. Mississippi residents). The researcher expected this to be very visible and noticeable in the descriptive statistics (such as the percentages). Indeed, the researcher intentionally included some of these "non-heavy-math" and "non-heavy-science" subjects in this research project in an attempt to see if there might be noticeable patterns, descriptively speaking.

Yet, upon looking at the data which was gathered and compiled, the researcher did not see nearly as great of differences as he expected (in terms of the percentages of graduate degrees awarded to Mississippi residents by the non-heavy-math, non-heavy-science graduate programs when compared to the heavy-math, heavy-science graduate programs). There were differences; but they were not as great as the researcher had expected them to be.

The one case of a really noticeably-high percentage of graduate degrees being awarded to Mississippi residents occurred in the case of the Master of Accountancy degree (M Accy), which in 75.1 % of the cases was awarded to Mississippi residents (and this was for 510 students over an approximately nine year time period). Accountancy (531 graduate degrees) was the second largest program (of the eight graduate degree programs in this research project) in terms of degrees awarded during the time period starting with Fall 2003 and continuing up through Full Summer 2012; only the Business Administration graduate degree program awarded more total graduate degrees (556) during this time period. Most (510) of the Accountancy graduate degrees were Master of Accountancy (M Accy) degrees; and so the Accountancy graduate degree program's high percentage (75.1%) of M Accy degrees awarded to Mississippi residents, along with Accountancy's large number (510) of students for the (M Accy) degree, had an upward effect on the GRAND TOTAL percentage (54.3%) of graduate degrees being awarded to Mississippi residents.

The researcher will now discuss, with a bit more depth, the concept of "heavy-math, heavy-science" subjects versus "non-heavy-math", "non-heavy-science" subjects as they are very informally designated here by the researcher, simply for the sake of being better able to juxtapose and compare them when trying to discuss any differences that may or may not exist between them. Overall, the research project included four graduate degree programs which were considered to be heavy-math and heavy-science degree programs: Chemistry, Engineering Science, Mathematics, and Physics. The research project also contained four graduate degree programs which were considered to be non-heavy-math and non-heavy-science degree programs: Accountancy, Business Administration, English, and History.

Of course, the researcher assumes that the Accountancy graduate program of study would likely have much difficult math; and the researcher also assumes that the Business Administration graduate degree program would probably have a strong dose of difficult math for calculating interest and many other such requirements necessary for business. However, the researcher does not believe that accountancy or business administration would generally be considered to be subjects that focus strongly on math which is at the "integral calculus-level," the "differential equation-level," the "linear algebra-level," the "vector-calculus level," in other words, the "heavy-math level," in the terminology of the researcher. And, while the researcher totally respects the massive amount of reading and writing (and other technical research work) which would likely be done by English graduate students and history graduate students, the researcher does not believe these subjects would be classified as heavy-math, heavy-science subjects. Of course, this does not mean that they do not require massive amounts of work and deep intelligence. It is just that they would be classified as something other than heavy-math and heavy-science subjects. And so, arguably, they might be more accessible to the general population of graduate students in Mississippi who had not received extensive training in high-level math and science subjects.

If the assumption is correct that Mississippi graduate students would find the subjects of English and history to be more accessible to them, academically speaking, then one might expect that they would gravitate more easily to these areas. This, is another reason that the researcher was generally expecting graduate degree programs such as English and History to have a higher percentage of their graduate degrees being awarded to Mississippi residents than would be seen for the heavy-math, heavy-science subjects. The researcher did find this to be true, descriptively speaking, in the degree programs of History, Business Administration, and Accountancy. However—excepting the case for Accountancy—the percentages were not as drastically different from the heavy-math, heavy-science subjects as the researcher had vaguely suspected.

Indeed, the percentage (57.6 % of 92 total degrees) of graduate degrees awarded to Mississippi residents by the Mathematics graduate degree program was very much comparable to the percentage (55.9 % of 111 total degrees) of graduate degrees awarded to Mississippi residents by the History graduate degree program. There is probably very little to no statistical difference between the percentages of those two programs, in this case. However, at least descriptively speaking, the English graduate degree program awarded a lower percentage (45.9 % of 109 total degrees) of its degrees to Mississippi residents over the roughly nine-year time period than did the Business Administration, Accountancy, and History graduate degree programs. The point of this is that in some cases (such as with the Mathematics degree program), the heavy-math, heavy-science subjects had relatively high percentages of graduate degrees being awarded to Mississippi residents—although this did not fit the general pattern seen in the descriptive statistics of the other three heavy-math, heavy-science degree programs (Chemistry, Engineering Science, and Physics). In a similar manner, there was a case (such as in the case of English) where a non-heavy-math, non-heavy-science program awarded a lower percentage of its graduate degrees to Mississippians than the GRAND TOTAL percentage of the graduate degrees which were awarded to Mississippians. In that case, English did not follow the normal pattern set by the other three non-heavy-math, non-heavy-science graduate degree programs (Accountancy, Business Administration, and History) which had percentages that (descriptively speaking) were above the group average (i.e. GRAND TOTAL) percentage of degrees being awarded to Mississippi residents. But, overall, the general pattern was for the heavy-math, heavy-science graduate degree programs to have lower percentages of their degrees being awarded to Mississippi residents .

The researcher also expected the subjects of business administration and accountancy to be very accessible, academically speaking, to the general population of Mississippi graduate students—and indeed, the data did end up showing high percentages of graduate degrees being awarded to Mississippi residents, especially in the case of

Accountancy (74.4 % of 531 degrees awarded) graduate degrees.   The Business Administration graduate degree program's percentage (58.6 % of 556 degrees awarded) of graduate degrees awarded to Mississippi residents was, descriptively speaking, slightly higher than the group average or GRAND TOTAL percentage (54.3 % of 1970 degrees) for all the eight degree programs included in this research project; but it was a little lower (relatively speaking) than the researcher expected .

The Business Administration graduate degree program did have a fairly high percentage (62.3 % of 480 students) of MBA degrees which were awarded to Mississippi residents. However, the researcher was surprised to see that the Business Administration graduate degree program awarded only 35.5 % of its PhD degrees to students classified as Mississippi residents. This surprised the researcher, because he was expecting the Business Administration PhD degree to be a degree that would be much more accessible to the average Mississippi graduate student.

Concerning the non-heavy-math, non-heavy-science subjects, it did cause the researcher to pause when noticing that the percentages (of graduate degrees awarded to Mississippi residents) seemed to often come out (roughly speaking) in the 50% to 60 % range. This seemed a little lower than the researcher had vaguely expected. The researcher possibly vaguely expected that such might be the case for some programs, but the researcher was surprised to see that it seemed to be a more consistent pattern than he had expected.

The researcher noticed that in nearly all of the eight degree programs (Chemistry, Business Administration, Accountancy, Engineering Science, History, English, and Mathematics), the percentage of degrees awarded to Mississippi residents was fairly low.

In other words, it seems apparent—at least for the eight subject areas which were investigated by the researcher—that it is very common (and seems to be the normal pattern) for these eight graduate degree programs to award a large percentage of graduate degrees to out-of-state students. This appears to the researcher to be a general pattern, although the researcher did notice that the subject of Accountancy seemed to have a noticeably higher percentage of in-state residents.

Overall, the researcher can only surmise that it would be likely that other degree programs (than the eight programs investigated by the researcher) would likely show a relatively high proportion of graduate degrees going to out-of-state residents. However, the researcher can only speak more certainly about the eight degree programs investigated—and even this would be based upon descriptive statistics.

The researcher concedes that perhaps he had had unrealistic expectations concerning the percentage of graduate degree recipients that would be awarded to Mississippi residents. The researcher admits that if time permitted another related research project, it would be good (in such a project) to obtain some extra data concerning the actual percentages of "in-state" vs. "out-of-state" students who apply to the graduate school at the University of Mississippi versus the percentages who graduate from the graduate degree programs. One might find that there is little difference between the relative percentages who apply and the relative percentages who graduate. However, this would open up many more topics to investigate.

The percentage of graduate degrees (74.4 %) awarded to Mississippi residents by the Accountancy graduate degree program seemed much more in line with what the researcher had vaguely suspected (or maybe, vaguely thought to be reasonable). But when the researcher really reflects upon it now, perhaps 50 to 60 % for graduate degrees awarded to in-state residents might be more reasonable than it seems to be at first glance. Perhaps it might line up with what one would expect based upon the percentage of in-state students that attend the University of Mississippi (and its graduate school)—and the researcher is unaware of these percentages.

On the surface, it does appear that the graduate degree programs which would traditionally have more heavy-math and heavy-science (such as Chemistry, Engineering Science, Mathematics, and Physics) did have a lower percentage of graduate degrees going to students who were classified as Mississippi residents. Indeed, Engineering Science seemed to award an especially low percentage (11.9 % of 84 PhD degrees) of graduate PhD degrees to Mississippi residents. Chemistry (24.0 % of 25 PhD degrees) was noticeably lower, as well, when it comes to percentage of PhD degrees awarded from the Fall 2003 semester through the Full Summer 2012 semester. Physics (38.9% of 18 PhD degrees) had a higher percentage of degrees awarded to in-state residents than did the Chemistry or Engineering Science graduate degree programs. This was somewhat of an unexpected result for the researcher, who generally speaking, expected the Physics graduate degree program to have the lowest percentage of all, when it comes to percentage of PhD degrees going to students who are classified as "Mississippi residents." However, as the researcher discussed previously, the 38.9 % of Physics PhD degrees (and the 41.5 % of total graduate physics degrees) which were classified as being awarded to "Mississippi residents" would need to be adjusted downward if one wanted to truly measure the percentage of graduate degree recipients who were born, raised, and educated in the state of Mississippi (and thus would be considered native Mississippians in a more traditional sense). But, the researcher concedes that for comparison purposes, the other graduate degree programs might experience a very similar phenomenon. The researcher cannot say this for certain, though, since he only was familiar (on a large-scale basis) with the population of physics graduate students. But it seems very reasonable to expect that other graduate degree programs would likely experience a similar phenomenon. This would be a good topic for future research in the field of physics education.

Again, it could be possible that many Mississippi natives travel to other universities to obtain graduate degrees rather than obtaining graduate degrees at the University of Mississippi. It was common among the "successful Mississippi-native physicists" who were interviewed to have obtained their graduate degrees from out-of-state institutions. This is another possible explanation which must be accounted for when trying to understand the fact that fairly high percentages of graduate degrees at the Univ. of Mississippi are awarded to out-of-state residents.

In summary, the percentage of graduate degrees awarded to Mississippi residents in the Physics graduate degree program at the University of Mississippi was lower, descriptively speaking, than the percentage of graduate degrees awarded to Mississippi residents in the graduate degree programs of Business Administration, Accountancy, English, History, or Mathematics at the University of Mississippi. This result was, for the most part, in alignment with what the researcher had originally expected, although the differences were not, overall, as drastic as the researcher had expected. Contrastingly, the percentage of graduate degrees awarded to Mississippi residents in the Physics graduate degree program at the University of Mississippi was higher, descriptively speaking, than the percentage of graduate degrees awarded to Mississippi residents in the graduate degree programs of Chemistry and Engineering Science at the University of Mississippi. This was somewhat unexpected, though not totally surprising to the researcher. Also, generally speaking (and descriptively speaking), a higher percentage of Master's degrees than PhD degrees were awarded to in-state (i.e. Mississippi) residents. The statistics, such as the percentages, are descriptive statistics; thus, although they often give a good overall picture of the basic patterns of how the percentages likely compare, they do not meticulously prove the statistical significance in each case of a percentage comparison. Lastly, all data concerning Mississippi residence must be interpreted in accordance to the fact that some students from other states or countries move to Mississippi and establish Mississippi resident status, although they were not born, raised, and educated in the state. The researcher verified that this occurs in the subject of graduate-level physics, but the researcher is not sure about whether or not this occurs in the graduate degree programs of other subject areas. The researcher hypothesizes that it does.

Research questions #3 and #4.

Since the Fall semester of 2003, what percentage of the physics graduate degree recipients at neighboring universities (such as the University of Alabama, Louisiana State University, the University of Arkansas, the University of Florida, and the University of Tennessee) were classified as in-state residents? Since the Fall semester of 2003, what percentage of physics graduate degree recipients at traditionally high-performing universities (such as New York University, the University of California at Berkeley, the University of Minnesota, the University of Colorado, and the University of Virginia) were classified as in-state residents?

Originally, the researcher had planned to obtain data from some universities which were in neighboring states to Mississippi—or states that were very close to being neighbors of Mississippi (such as in the case of Florida). The main reason that the researcher chose to do this was because the researcher was interested in how other "Southern" states would compare with Mississippi. (Of course, the Southern states would be those states which are located in the Southeastern and South-Central United States—the region known as "the South," which had once seceded from the other parts of the United States in the 1860's.) The researcher had originally wanted to investigate the concept of Southern Science—or possibly, the lack thereof—more deeply. However, as the research design was being fine-tuned, it was determined that such an investigation would somewhat fall outside of the main focus of this research project. Thus, while it was not the main focus of this research project, the researcher did include some information of a cultural/historical nature concerning Southern Science (see Appendix A). Also, Research Question #3 and Research Question #4, in some sense, investigate certain topics which might be peripherally related to the concept of Southern Science.

However, the main focus of this part of the research was still the physics education aspect of measuring how many "in-state students" were receiving graduate physics degrees in other graduate schools. Altogether, the researcher included a mixture of universities from neighboring states (i.e. Southern states), as well as universities from states in other parts of the country. The researcher had originally planned to obtain data from "traditionally high-performing" universities, mostly from "non-Southern" states.

The list of universities which the researcher had originally planned to include in sample of "traditionally high-performing" universities was as follows: New York University, the University of California at Berkeley, the University of Minnesota, the

University of Colorado, and the University of Virginia. (And, the researcher concedes that the term “high-performing” was not well-defined, and was used rather loosely. Mainly, the researcher wanted to obtain a sample of states which generally would be thought to be high-performing, and which were located fairly far away from Mississippi, geographically speaking—so that they would not be considered Deep South states.) The researcher did try to contact officials from the graduate schools at each of the five “traditionally high-performing” universities, in an effort to obtain the necessary data. In many cases, phone calls were made or messages were sent via email. However, ultimately, the researcher was only able to obtain the necessary data from two of these universities: the University of Minnesota and the University of Virginia.

The list of universities which the researcher had originally planned to include in sample of “neighboring universities” (to the University of Mississippi) was as follows: the University of Alabama, Louisiana State University, the University of Arkansas, the University of Florida, and the University of Tennessee. The researcher made many phone calls and emails throughout this portion of the research. Ultimately, the researcher was able to obtain the necessary graduate school data from the following three universities among the sample of neighboring universities: the University of Alabama, Louisiana State University, and the University of Arkansas.

At the start of the research project, he researcher hypothesized that the universities from the neighboring Southern states would possibly have similar percentages (to the University of Mississippi) of their physics graduate degrees going to their in-state students. The researcher assumed, in some senses, that the universities in these other Southern states (or in these cases, Deep South states) would experience many of the same conditions as Mississippi, and thus would have similar outcomes, academically speaking. However, the researcher really did not know fully what to expect. Part of the reason the researcher wanted to investigate this issue was to see whether or not the University of Mississippi was an anomaly when compared to universities in neighboring states (in terms of the percent of graduate physics degrees that were awarded to in-state students).

And, when compared to the traditionally "high-performing" universities, the researcher somewhat expected that the University of Mississippi (and the universities from its neighboring Deep South states) would likely award a lower percentage of their graduate degrees to in-state students than would the universities in the sample of traditionally high-performing universities. Overall, the results of this portion of the research contradicted the researcher's vague expectation that the University of Mississippi would likely award a lower percentage of their graduate physics degrees to in-state students than the other universities in this research project would. The descriptive statistics—at least for these six universities in this research project—showed that the University of Mississippi (during the time periods which were compared) awarded a higher percentage of their graduate physics degrees to students classified as in-state residents than any other university among the six universities. However, the sample size is very low—with only six universities being included in this portion of the research. Thus, one must realize that when comparing these percentages, they are descriptive comparisons that paint a basic picture; but they do not decisively and conclusively prove the statistical significance of a certain comparison.

Also, some major uncertainties which could totally change the meaning of the data concern the issue of how the various graduate schools (or the officials at those schools) determine "residency status," as well as the issue concerning the proportion of students who establish residency in the state (of their university) even though they were not born, raised, and educated in the state in the traditional sense; if these two issues differ greatly from state to state (and university to university), then the comparative value of the data would be greatly affected.

Although the researcher has already included the more extensive data tables which show the data broken down year-by year (see Table 15-Table 30 in Appendix D), the researcher will include the following summary table (see Table 376) which condenses that information into a form that will be more concise for answering the research question:

Table 376

Summary Data for the Percent of Physics Graduate Degrees Awarded to Students Classified as In-state Residents at Six Different Universities

University	Total Number of Physics Master's Degrees Awarded	% In-State Residents (for Physics Master's Degrees Awarded)	Total Number of Physics PhD Degrees Awarded	% In-State Residents (for Physics PhD degrees awarded)	Total Number of Physics Graduate Degrees Awarded	% In-state (for Physics Graduate degrees awarded)
University of Alabama *(June 2002-May 2013) (11 yrs)*[a]	55	23.6 %	50	8.0 %	105	16.2 %
University of Arkansas *(2002-2012) (11 yrs)*	64	37.5 %	32	9.4 %	96	28.1 %
Louisiana State University *(Summer 2003-Spring 2012) (9 yrs)*	71	29.6 %	61	19.7 %	132	25.0 %
University of Mississippi *(Fall 2003-Summer 2012) (9 yrs)*	35	42.9 %	18	38.9 %	53	41.5 %
University of Minnesota[c] (*July 2002-June 2012) (10 yrs)*	84	27.4 %	159	24.5 %	243	25.5 %
University of Virginia *(2003-2012) (10 yrs)*	59	35.6 %	105	43.8 %	164	40.9 %

Note. Some major uncertainties which could greatly affect the meaning of the data concern the issue of how the various graduate schools (or officials at those schools) determine "residency status," as well as the

issue concerning the proportion of students who establish residency in the state (of their university) even though they were not born, raised, and educated in the state in the traditional sense; if these two issues differ greatly from state to state (and university to university), then the comparative value of the data would be greatly affected. For example, see note below Table 30 (concerning some of UVA's policies).
[a]The year values shown here (such as "11 yrs" or "9 yrs" and so on) should be taken as a rough approximation. Each university sent their data to the researcher in a different form; the data was arranged in different ways. (See Tables 1-30 for more detail about how each respective university sent their data and determined their "academic years," as far as the data they sent was concerned.)
[b]The data from Louisiana State University, concerning the PhD graduate degrees, was listed in terms of "doctoral degrees" in physics rather than "PhD" degrees in physics; the researcher (P. Rogers) made the assumption that these doctoral degrees in physics were PhD degrees.
[c]The data concerning University of Minnesota includes the data which was sent from both the University of Minnesota (Duluth) and University of Minnesota (Twin Cities) (see Table 21, Table 22, and Table 23).

Once the researcher obtained the above summary table of descriptive statistics, one major data item stood out to the researcher: the fact that the University of Mississippi actually had very high percentages, descriptively speaking, when compared to the other universities. When its descriptive statistics are compared to those of the other universities in this research project, the University of Mississippi had the highest percentage, in terms of master's degrees being awarded to students who were classified as "in-state" residents. In terms of PhD degrees being awarded to in-state residents, the University of Mississippi had the second highest percentage; only the University of Virginia had a higher percentage of its PhD degrees being awarded to in-state residents.

In terms of the percentage of total graduate physics degrees awarded to in-state residents, the University of Mississippi had the highest percentage (closely followed by University of Virginia). [However, it seems that the Univ. of Virginia might have a policy which encourages graduate students to apply for in-state residency (see note below Table 30), and the researcher is not completely sure about how this influenced the University of Virginia's residency data.] The observation that, when compared to the University of Mississippi, the other universities had even lower percentages of their physics graduate degrees going to in-state residents was a surprise to the researcher. It did not agree with the researcher's original hypothesis which, for the most part, assumed that the other universities would have higher percentages of their graduate degrees going to in-state residents than the University of Mississippi would. The following graph (Figure 5) shows a graphical display of these findings.

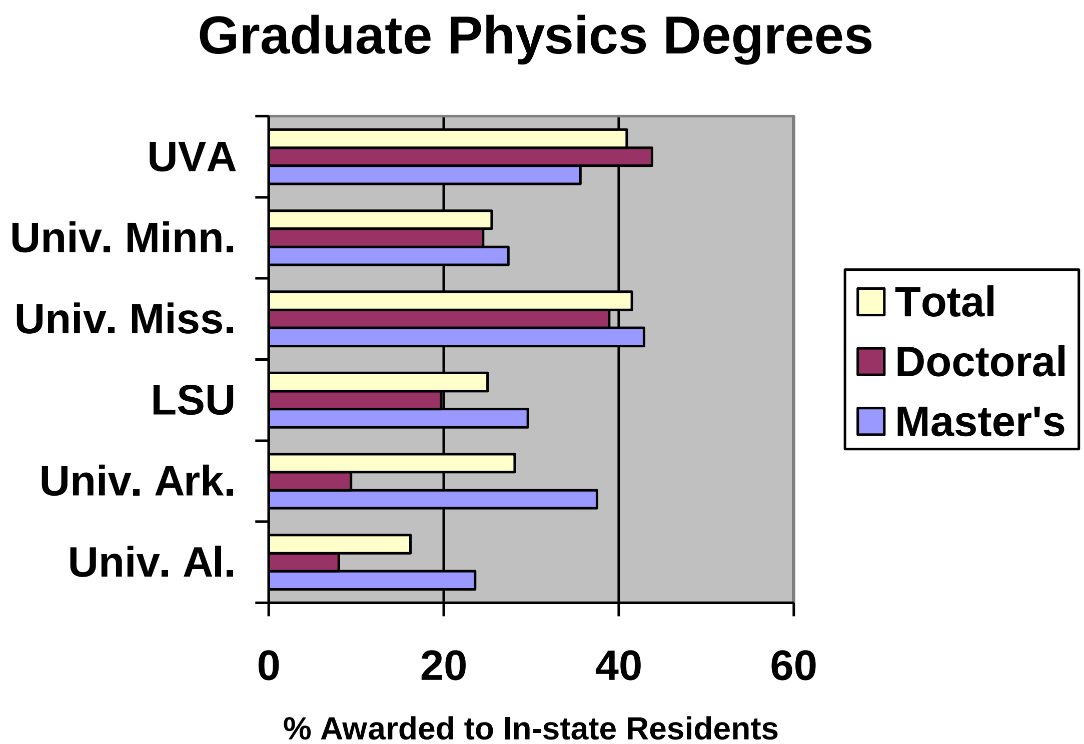

Figure 5. The graph above shows the percent of graduate physics degrees which were awarded to students who were classified as in-state residents. The six universities which were included in this portion of the research project were the University of Alabama (Univ. Al.), the University of Arkansas (Univ. Ark.), Louisiana State University (LSU), the University of Mississippi (Univ. Miss.), the University of Minnesota (Univ. Minn.), and the University of Virginia (UVA). The time periods studied were not perfectly convergent (see Table 376) for each university, but roughly covered the period of time between 2002-2013.

The information in Table 376 was condensed a little more (see Table 377) in order to obtain a vague picture of how the data from the Univ. of Mississippi compared with the data from universities from some neighboring states and the universities which were meant to be part of the "traditionally high-performing" sample.

Table 377

Comparison by Regions, for the Percent of Physics Graduate Degrees Awarded to Students Classified as In-state Residents (Covering Approximately a 10 Year Time Period in the Early 2000s)[a]

Universities in this Research Project	Total Number of Physics Master's Degrees Awarded	% In-State Residents (for Physics Master's Degrees Awarded)	Total Number of Physics PhD Degrees Awarded	% In-State Residents (for Physics PhD degrees awarded)	Total Number of Physics Graduate Degrees Awarded	% In-state (for Physics Graduate Degrees Awarded)
Three Neighboring Universities from Deep South States[b]	190	30.5 %	143	13.3 %	333	23.1 %
University of Mississippi *(Fall 2003- Summer 2012) (9 yrs)*	35	42.9 %	18	38.9 %	53	41.5 %
Two Traditionally High-Performing Universities from other Geographic Locations[c]	143	30.8 %	264	32.2 %	407	31.7 %
GRAND TOTAL (Compiled of Data for All 6 Universities)	368	31.8 %	425	26.1 %	793	28.8 %

[a]See previous table where the more precise time period covered is shown for each university.
[b]This sample included the University of Alabama, the University of Arkansas, and Louisiana State University. The state of Arkansas, might be more classified as a "mid-South state" by many people; however, one could also likely argue that it could be classified as a Deep South state.

[c]This sample included the University of Minnesota and the University of Virginia. The term "high-performing" was used somewhat loosely by the researcher, who would really need to obtain more supporting data if such a term is meant to be taken more literally. However, these universities do come from geographic regions far removed from the University of Mississippi. It does need to be mentioned that Virginia is often considered to be a quintessential southern state; yet, it arguably also has many features in common with Northeastern states. Virginia was, arguably, often thought of as the "most elite" Southern state. Although Virginia is definitely classified as a Southern state, it is never classified as a Deep South state such as Alabama, Louisiana, and Mississippi (and arguably Arkansas) would be.

At the beginning of the research project, the researcher did not expect the University of Mississippi to have the highest percentage (descriptively speaking), in terms of graduate degrees being awarded to in-state residents. The researcher expected all of the Southern universities (in this case, Deep South universities) to have relatively low percentages of their graduate degrees being awarded to in-state residents. Overall, this seemed to be somewhat true for some of the other Deep South universities in this research project—especially when it comes to the percentage of PhDs awarded to in-state students. For example, the Univ. of Arkansas and the Univ. of Alabama both awarded less than 10 % of their physics PhD degrees to students who were classified as "in-state" students. This was, descriptively speaking, lower than the GRAND TOTAL of 26.1 % (which was calculated from the compiled data of all six of the universities in this project).

In light of the descriptive data that has been compiled concerning the percent of graduate degrees being awarded to in-state residents, the University of Mississippi's data more closely resembled the data from the two "traditionally high-performing" universities (from other geographic locations) than it resembled the data from the three neighboring universities from Deep South States. This was also an unexpected result for the researcher. Overall, the data from the University of Mississippi compared more similarly to the data from the University of Virginia, which was classified as a “traditionally high-performing” university for the sake of this research project. However, the Univ. of Virginia might have a policy which encourages graduate students to apply for in-state residency (see note below Table 30). This created much uncertainty in the researcher’s mind concerning the in-state residency data from Univ. of Virginia.

The researcher is very aware that this is a small sample size, and thus the results must be “taken with a grain of salt.” In other words, one must not jump to immediate and strong conclusions. The researcher is also aware that comparing such percentages in this way does not prove statistical significance, mathematically speaking. In some cases, there might be no statistical difference between the percentages, even though they calculated out to give slightly different numbers. However, the researcher feels that descriptive statistics provide an important starting point for future researchers. They are good for giving a basic picture or description of a complex array of information which otherwise might be hard to digest. And, sometimes, we can make definitive statements—such as, we can definitely say that at least for the data that was provided, these six universities in this study all awarded more graduate physics degrees to “out-of-state” students than they did to in-state students (over the time period involved in this study). We see that a definite pattern is being followed—at least by these six universities. We see that the University of Mississippi is not an anomaly in this matter of granting more graduate physics degrees to out-of-state students than to in-state students.

The researcher cannot say for certain why the various universities (which provided the data) award more graduate physics degrees to out-of-state students than to in-state students. One possible explanation is that perhaps students generally tend to attend graduate school at colleges or universities in another state than their native state.

This was common among the "successful Mississippi-native physicists" who were interviewed in this research project. However, the researcher cannot say for sure whether or not attending graduate school in another state is a general and common practice in Mississippi or around the nation—nor can the researcher assess the effect this has on the actual percentages which were measured in this research project. Perhaps competition from international students is also a major factor. This particular research question did not deal with the deeper reasons which underlie the phenomenon, but rather with the actual measurement of the percentages of graduate physics degrees awarded to in-state students at these universities. Perhaps future research studies could be designed to delve deeper into the various reasons why large proportions of graduate physics degrees are awarded to out-of-state students at these universities.

The researcher must now mention again that this data came from a variety of sources, and was not uniform in appearance or organization. However, the years for the degrees and the degree types were provided. Generally, the data was broken down into a year-by-year analysis, shown in rows and columns of data. However, there was generally still more work for the researcher to do to organize all the data in such a way that a more uniform year-by-year comparison could be made between the various universities. A major item which could make this data uncertain is how "residence status" was determined by each state. The researcher provided many footnotes under the more expanded tables (see Tables 15-30) in an attempt to explain more information about how the "residence status" was determined by each graduate school. Yet, in the final analysis, one must realize that the data for residence status was apparently determined in different ways (at the different universities), and this adds an element of uncertainty. For example, it seems that graduate students at the University of Virginia might actually be encouraged to apply for in-state residency (see notes below Table 30).

Another uncertainty was the fact that the Academic Years were determined in different ways. However, the researcher tried to make sure that even though the academic years might be determined in slightly different ways, the data was still broken down in such a way as to compare them roughly year-by-year. More information on how the academic years were determined was also included in Tables 1-30 (and their footnotes). Also, the researcher was very dependent on other officials who sent the data. The researcher had to assume that the data which was sent to him was compiled accurately by the officials at the various graduate schools. This also adds uncertainty.

As stated previously, all data concerning in-state residence status must be viewed in the light that many students might change their residence status to the state where they have moved to attend school. There are likely requirements by each state which oversee this—such as, perhaps the requirement of remaining in the state for a year and paying taxes. However, the researcher is unaware of all of such legal requirements. And, if a university is truly concerned with understanding how well it is educating its native-born students (who will usually be more likely to stay in the state), the universities must be aware of the fact that students sometimes change their residence status to match the state where they are attending school. The researcher has verified that this did happen in the sample of physics graduate students from the Univ. of Mississippi. The researcher did not try to investigate whether or not it happens at other universities or in other graduate programs. However, the researcher assumes that it does happen, and so this must be accounted for if admissions officials truly wish to measure how well the university is educating the native-born citizens of that particular state.

Finally, however difficult this data was to obtain for this portion of the research project, and however non-uniform it might be, the researcher hopes that it will help us better understand physics education as it concerns the education of graduate students of physics, whether in-state or out-of-state. The researcher realizes that the data from this portion of the experiment was somewhat non-uniform and that the sample-sizes were small. Thus, while this must temper any decisive conclusions one might make from these results, the researcher does hope that they will serve as a type of “first-broad-picture” of a very complicated topic which future researchers can study.

Research question #5.

Approximately what proportion of Mississippi high schools offer physics to their students, and has this proportion changed dramatically over time?

At the outset, the researcher must mention that he was unable to fully address this question or to give any definite answers concerning this question. However, this question was very peripherally (and only partially and indirectly) addressed by some of the student survey questions, such as the question which asked the students if their high school offered physics; or the question which asked the students if they took physics in high school. The answers to these survey questions were meant to determine whether or not a high proportion of the physics students had the chance to take physics in high school. The survey questions also addressed what percentage of our Mississippi students (in that sample of 113 physics lab students) actually took physics in high school. However, these survey questions—though useful for understanding whether or not that particular sample was exposed to physics in high school—do not fully answer the research question. And, the questions on the student surveys do nothing to address the portion of this particular research question which concerns whether or not the proportion of Mississippi high schools offering physics to their students has changed dramatically in time.

To fully address this question with a much higher degree of certainty, the researcher would need to analyze a fairly large amount of data—and data which covered more than just one year in time. The researcher (Paul Rogers) has not been able to conduct an analysis which will properly address this question, and so the researcher has not been able to fully address this particular research question. This was partially due to the fact that the research project became so expansive and so broad that the researcher was only able to turn his attention to this question at a rather late stage of the research process—and the researcher would possibly have required a another extension in time in order to fully address this research question, properly. However, the researcher did make some initial efforts to address this research question when he finally reached this stage of the research process. The researcher (Paul Rogers) sent a data request to officials at the Mississippi Department of Education for educational data which would hopefully help the researcher address this research question. The data request was for some data from the public schools from several years ago, as well as some more recent data. The researcher (Paul Rogers) was told that it would cost a certain fee in order to pay officials at the Mississippi Department of Education to research that information.

The researcher (Paul Rogers) did pay the fairly expensive fee for the research to be carried out, and the results of the research were sent to Paul Rogers. However, although there is probably much useful information in the data which was sent, the data was not yet in a fully condensed form which could be immediately used to answer the research question. The data that was sent would need to be compiled further. The researcher (Paul Rogers), as of this date (Fall 2017), has not yet compiled that particular data any further. Thus, an additional extension of time would possibly be needed in order for the results to be fully compiled in such a way as to attempt to answer the research question more precisely.

However, as alluded to earlier, the researcher did find some information from the student surveys which somewhat relates to this research question—although in a very indirect way and inconclusive way. According to the survey results of the 53 "Mississippi Native" students, 92.5 % answered "Yes" when asked if physics was offered at their high school. The people in the sample of "Mississippi Natives" were given that designation if they indicated (on the survey forms) that they were born in Mississippi and that they obtained most of their high school education in Mississippi. They had to meet both requirements to be designated in the sample of "Mississippi Natives" for the purposes of this research (and 53 of the 113 students surveyed met the requirements to be classified as "Mississippi Natives" for this research project). Since 92.5 % of these 53 students (i.e. "Mississippi Natives") in the sample indicated that physics was offered in high school, one can say (at least descriptively) that the Mississippi natives in the sample of students who were surveyed in the Physics II labs (at Univ. of Mississippi) did have physics courses available to them in their high schools.

Furthermore, according to the results of the survey, 58.5% of the sample of 53 "Mississippi Native" physics students indicated that they took at least one (or in some cases more than one) physics course in high school. Thus, at least in this particular sample that was surveyed—which consisted of 5 separate classes (some in summer of 2012 and some in the spring of 2013)—there was a wide exposure to high school physics. The vast majority (92.5 %) went to high schools that offered physics, and many of the students (58.5%) took at least one (or more, in some cases) of those physics classes. These descriptive statistics indicate—although they do not prove—that the Mississippi-born, Mississippi-educated (high school) students who come into the Physics II labs at the University of Mississippi have likely attended high schools where physics was available to them. This does nothing, however, to speak about the quality of that high school teaching, such as whether or not the physics teachers they had were certified to teach the subject of physics or otherwise had the proper academic background to teach physics. Plus, as mentioned before, the labs in which the surveys were conducted were Physics II labs. The students in Physics II labs have already experienced the selective factor of having to pass Physics I. In other words, the students who were able to pass were "selected out," whereas those who were not able to pass were "weeded out" of the group (i.e. removed from the group), statistically speaking. Thus, the descriptive statistics can only show that the great majority (92.5 %) of Physics II lab students in the "Mississippi Native" sample went to high schools where a physics course was offered.

The table below shows contains some condensed information from the survey results, so that one can make comparisons among a few of the "sample groups" which were surveyed on the question of whether or not a physics course was offered at their high schools (see Appendix C for Question #1 of the *Mississippi Physics Education: Student Survey Form* or Question #1 of the *Mississippi Physics Education: Instructor*

Survey Form). A second data table (following the one below) also shows how some of the student sample groups answered Question #2 on the Student Survey Form, which asked how many physics courses they had taken in high school.

Table 378

Survey Answers Given by Various Samples of Physics Students (and Physicists) to Question #1 of the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Entire Group (N_{Total} = 113)	MS Natives (N_{MS} = 53)	Other Americans (N_A = 54)	Physics Instructors (N_{PI} = 16)
Yes	95.6 %	92.5 %	98.2 %	93.8 %
No	3.5 %	5.7 %	1.9 %	6.3 %
I don't know	0.9 %	1.9 %	0.0 %	0.0 %

Note. The "Entire Group" included all the 113 physics students who were surveyed, including international students. To see how each group was precisely defined, see the original survey results tables which were tabulated for each sample. The precise way each group was defined was generally discussed at the start of each sample's tabulated results tables.

Table 379

Survey Answers Given by Various Samples of Physics Students to Question #2 of the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Entire Group (N_{Total} = 113)	MS Natives (N_{MS} = 53)	Other Americans (N_A = 54)
0	28.3 %	41.5 %	14.8 %
1	51.3 %	47.2 %	59.3 %
2	18.6 %	9.4 %	24.1 %
3	0.9 %	1.9 %	0.0 %
more than 3	0.0 %	0.0 %	0.0 %
No Answer Chosen	0.9 %	NA	1.9 %

Observing the two previous summary data tables (Table 378 and Table 379), one sees that each of the samples shown in the above tables (i.e. the "Entire Group, the "Mississippi Natives", the "Other Americans", and the "Physics Instructors") indicated (with over 90% "Yes" answers in each case) that a physics course was offered at their high school. When comparing, descriptively, whether or not the students (and physicists) went to high schools where a physics course was offered, the sample of "MS Natives" did have the lowest percentage (92.5 %) of these four samples which were compared above. However, these differences are very small, and are possibly statistically insignificant—although further statistical tests would need to be carried out to begin to approach the question of statistical significance in this case.

Table 379 above shows that for all three groups which were being compared in the table (i.e. "Entire Group", "MS Natives", and "Other Americans"), a majority of the students in the sample did take one or more physics courses in high school. However, in this comparison, the sample of "MS Natives" did have the highest percentage (41.5 %) of students who answered that they did not take physics in high school. It appears that, generally speaking, this was not because their high schools did not offer physics, because 92.5 % of the "Mississippi Natives" indicated that their high school did offer physics.

One might then wonder how the "Mississippi Natives" in the sample performed in their college physics classes compared to the other three sample-groups which are being compared here. The summary table below (see Table 380) shows the "self-evaluation" answers of students to Question #5 on the *Mississippi Physics Education: Student Survey Form* which asks them to describe their college physics performance with a letter grade.

Table 380

Survey Answers Given by Various Samples of Physics Students to Question #5 of the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Entire Group (N_{Total} = 113)	MS Natives (N_{MS} = 53)	Other Americans (N_A = 54)
A	53.1 %	56.6 %	51.9 %
B	34.5 %	30.2 %	37.0 %
C	10.6%	11.3 %	9.3 %
D	1.8 %	1.9 %	1.9 %
F	0.0 %	0.0 %	0.0 %
Not Applicable	0.0 %	0.0 %	0.0 %

Note. It is important to realize that the students who were surveyed were Physics II lab students. Thus, one assumes that unless they somehow skipped Physics I (via special tests, etc.), they had already passed their Physics I college courses. Hence, it will not be so unusual that the vast majority of them evaluated their college physics performance with a C or higher.

The table above demonstrates that according to the "self-evaluation" grades of the students who were surveyed, the "Mississippi Natives" apparently performed as well as the other samples, overall—even if fewer of the "Mississippi Natives" took a high school physics course. However, this is a very weak indicator, and it is only meant to get some picture—however vague—of how the students might be doing in their classes.

Another question might arise concerning whether or not "A" students have had a greater exposure to high school physics than "B" or "C" students. Perhaps the "A" students had physics available to them in their high schools, whereas maybe the "C" students did not have physics available to them. Although this research design cannot answer such questions, broadly speaking, for the entire population of physics students, it can portray a broad picture of the particular sample of students who participated in the surveys. In other words, the surveys provided descriptive statistics which could at least paint a picture for this particular sample of 113 Physics II lab students.

Descriptive statistics could, of course, also be performed on smaller groups within the larger group sample. For example, the researcher tabulated the survey data for the samples of “A-level College students”, “B-level College Students”, and “C-level or Below College Students”. This was done in an attempt to see if there were possible differences between the A-students, the B-students, and the C-students (or lower). The following two tables (Table 381 and Table 382) show some of the summary data which was gathered from these various groups’ answers to Question #1 and Question #2 of the "Mississippi Physics Education: Student Survey Form" (see Appendix C).

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Table 381

Answers Given by the “A”, “B”, “C or Below”, and “Mississippi Natives” Physics Students to Question #1 of the Student Survey Form, “Was a physics course offered at your high school?”

Answer	A-level College Students ($N_{AL} = 60$)	B-level College Students ($N_{BL} = 39$)	C-level or Below College Students ($N_{CL} = 14$)	MS Natives ($N_{MS} = 53$)
Yes	96.7 %	97.4 %	85.7 %	92.5 %
No	3.3 %	2.6 %	7.1 %	5.7 %
I don’t know	0.0 %	0.0 %	7.1 %	1.9 %

Table 382

Survey Answers Given by "A", "B", and "C or Below", and "MS Natives" Physics Students to Question #2 of the Student Survey Form, "How many physics courses did you take in high school?"

Answer	A-level College Students ($N_{AL} = 60$)	B-level College Students ($N_{BL} = 39$)	C-level or Below College Students ($N_{CL} = 14$)	MS Natives ($N_{MS} = 53$)
0	23.3 %	35.9 %	28.6 %	41.5 %
1	55.0 %	48.7 %	42.9 %	47.2 %
2	20.0 %	15.4 %	21.4 %	9.4 %
3	1.7 %	0.0 %	0.0 %	1.9 %
more than 3	0.0 %	0.0 %	0.0 %	0.0 %
No Answer Chosen	NA	NA	7.1 %	NA

Upon observing the two preceding tables, one sees that most of the Physics II lab students did go to a high school where a physics course was offered. When compared to the "A" sample and "B" sample, the "C or lower" sample did have a lower percentage of students who went to a high school which offered a physics course. The sample size for the "C or lower" group was only 14, so the percentages only give us a basic description of this particular sample. There is probably not enough evidence from such a small sample ($N_{CL} = 14$) to conclude that the percentage is generalizable.

One of the main purposes of this particular research question was to explore the possibility that many Mississippians do not perform well in physics because they are not exposed to it in high school. And, this may be the case for many students—the researcher cannot yet say about that. However, the researcher can say that, at least descriptively speaking, the students who were surveyed in the Pre-med Physics II labs and Engineering Physics II labs at the University of Mississippi (in Summer 2012 and Spring 2013) did have a high exposure to physics in high school, for the most part. Indeed, even 85.7 % of the "C or lower" students went to high schools that offered physics. However, the percentage of the "C" students who attended a high school which offered physics was less, descriptively speaking (for this sample), than the percentage of "A" or "B" students who attended a high school which offered physics. This does raise questions that hopefully other researchers can continue to pursue.

Ultimately, the data shown in the preceding few tables only answers peripheral questions to this particular research question. The data from the student surveys indicates that, at least descriptively speaking, large percentages of the Physics lab II students do have exposure to high school physics. However, the survey data does not answer the question concerning the proportion of Mississippi high schools which offer physics and whether or not that has changed over time. Perhaps future researchers can pursue more detailed and precise answers to that particular research question.

Research question #6.

What are some of the physics attitudinal factors held by physics students at the University of Mississippi, especially as concerns their views toward their own ability to be competent physics students (i.e. their physics self-efficacy views)?

For the purposes of this research, the researcher wanted to investigate the physics self-efficacy (i.e. the students' views as to whether or not they have the ability to be competent physics students). The researcher thus included survey questions on the student survey form which were meant to measure the students' perceptions about their physics ability. On the Student Survey Form (see the *Mississippi Physics Education: Student Survey Form* in Appendix C), Questions #8-12 and Questions #14-16 are examples of some of the most pertinent survey questions which the researcher included to help measure the students' perceptions about their own physics ability—or their competence in physics.

Table 383

Survey Answers Given by Various Samples of Physics Students to Question #8 of the Student Survey Form, "How good are you at math?"

Answer	Entire Group (N_{Total} = 113)	MS Natives (N_{MS} = 53)	Other Americans (N_A = 54)
Excellent	33.6 %	41.5 %	29.6 %
Above Average	50.4 %	43.4 %	55.6 %
Average	15.0 %	15.1 %	13.0 %
Below Average	0.9 %	0.0 %	1.9 %
Poor	0.0 %	0.0 %	0.0 %

Table 384

Survey Answers Given by Various Samples of Physics Students to Question #9 of the Student Survey Form, "How good are you at physics?"

Answer	Entire Group (N_{Total} = 113)	MS Natives (N_{MS} = 53)	Other Americans (N_A = 54)
Excellent	8.0 %	13.2 %	3.7 %
Above Average	43.4 %	35.2 %	50.0 %
Average	41.6 %	43.4 %	38.9 %
Below Average	4.4 %	3.8 %	5.6 %
Poor	0.9 %	1.9 %	0.0 %
Other	1.8 %	1.9 %	1.9 %

The data in the two preceding summary tables (Table 383 and Table 384) suggests that for the sample which was surveyed, a great majority of them feel confident that they are above average to excellent in math. For example, when looking at the "Entire Group" (N_{Total} = 113) of students in the sample, 84.0 % rated themselves either "Above Average" or "Excellent" in math. However, they do not rate themselves as well in physics (at least, descriptively speaking). For example, when looking at the "Entire Group" (N_{Total} = 113), only about half of the sample (or 51.4 %) rated themselves as "Above Average" or "Excellent" in physics.

Indeed, only 8.0 % of the "Entire Group" rated themselves as "Excellent" in physics, while 33.6 % of the "Entire Group" rated themselves as "Excellent" in math (see Figure 6 for graphical representation). This suggests some disconnect that would be worth investigating further. Perhaps the students are over-rating their math abilities. Another possibility is that the students really are proficient in math, but are struggling with the concepts of physics. In other words, they may not be able to properly apply their math if they do not understand the concepts properly.

If it is true that the students struggle to understand the concepts of physics, one could investigate a myriad of reasons why: time concerns, pace of the class, volume of material to be covered, outside distractions, inability to digest the material in the book, poor study habits, and so forth. These are areas that future researchers could perhaps continue to investigate. The summary data above only paints a picture, with descriptive statistics. On the surface, it suggests that there is some disconnect that occurs between students being able to be perceive themselves as proficient in math versus them being able to perceive themselves as proficient in physics (see Figure 6 below).

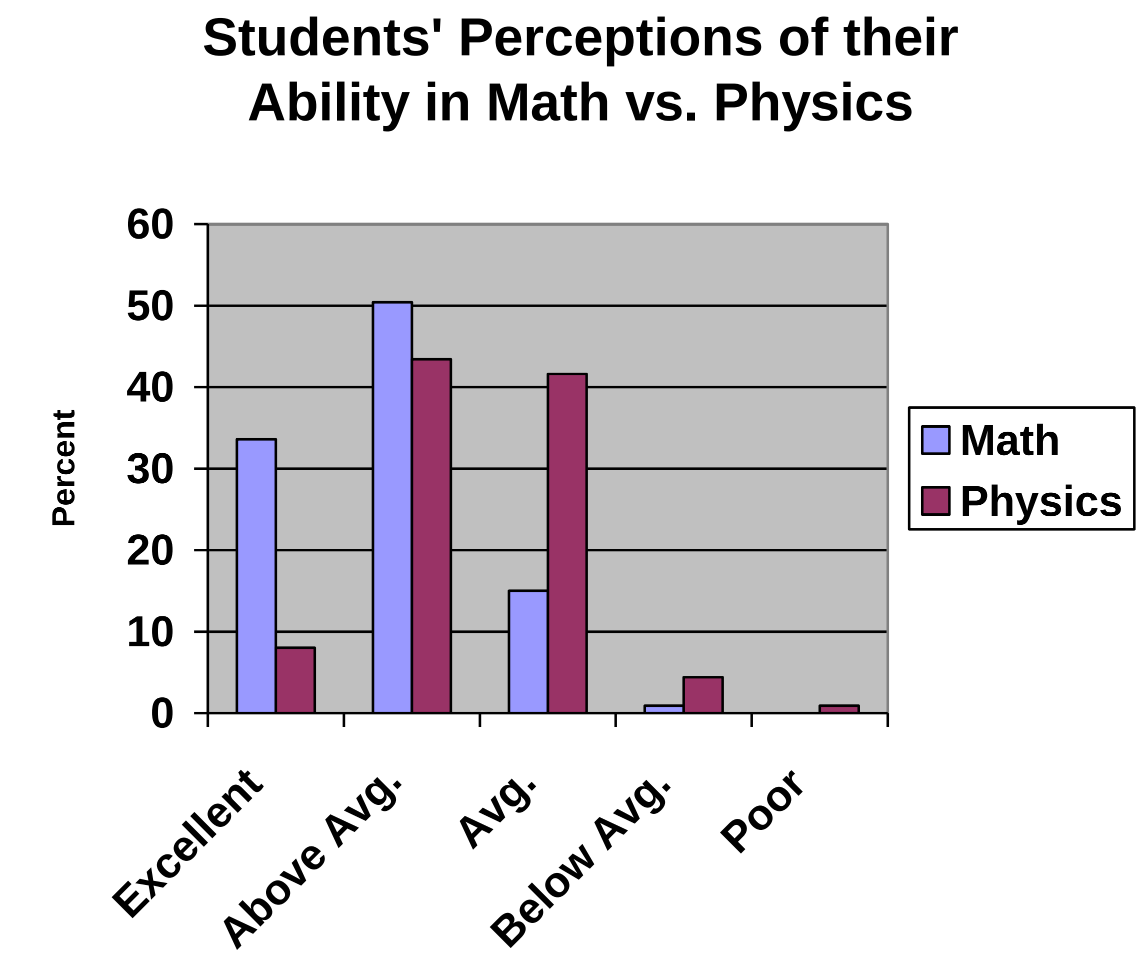

Figure 6. The graph above shows how the “Entire Group” of 113 Physics II lab students responded to Questions #8 and #9 on the Student Survey Form. These survey questions asked the students to rate themselves concerning how good they are at math; and then how good they are at physics. (Note: the 1.8 % of students who gave an “Other” response on Question #9, concerning physics, are not shown in the graphical results.)

Table 385

Survey Answers Given by Various Samples of Physics Students to Question #10 of the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?[a]*"*

Answer	African-Americans (N_{AA} = 13)	European-Americans (N_{EA} = 76)	Asian-Americans (N_A = 5)	Other Ethnicities[b] (N_{OE} = 11)
Much better	7.7 %	10.5 %	40.0 %	18.2 %
Better	0.0 %	15.8 %	60.0 %	9.1 %
The Same	53.9 %	56.6 %	0.0 %	54.6 %
Worse	30.8 %	9.2 %	0.0 %	9.1 %
Much Worse	0.0 %	1.3 %	0.0 %	0.0 %
No Answer was Chosen	7.7 %	6.6 %	0.0 %	9.1 %

Note. There was also a sample of students who did not choose any ethnicity; these were the students who chose not to answer the optional question regarding ethnicity on the student survey form. (To see that particular optional question, look on the first page of the *Mississippi Physics Education: Student Survey Form* which is included in Appendix C). In other words, these students left that particular optional question blank, with no answer circled. Thus, they did not choose any ethnicity at all. The researcher included an analysis of their surveys under the sample titled "Chose No Ethnicity" (N_{CN} = 8). The compiled results of their survey answers are shown in the section which shows the tables for the compiled results of all the surveys (for each sample that was analyzed).

[a]The purpose of this question was to help gain information about how students of different ethnicities view their own ethnicity group as it relates to being good at physics. The researcher hopes that this will further increase our understanding of "self-perception," especially as it relates to physics self-efficacy beliefs. The researcher hopes this information will be useful to any group of people who wish to improve their understanding of science education, no matter their ethnicity.

[b]This sample included students who indicated ethnicities which could not be placed into the categories of "African-Americans," "European-Americans," or "Asian-Americans." There were several ethnicities represented in the sample labeled as "Other Ethnicities," but the sample sizes would have been extremely small. Thus, the researcher grouped them all together in the sample labeled as "Other Ethnicities" (N_{OE} = 11).

Another aspect of physics self-efficacy which the researcher wanted to investigate was how students perceive their own ethnic groups, in terms of physics competency. The results in summary table above show that there are differences in how ethnic groups rate themselves. This is important for teachers to understand. Perhaps it is more difficult to learn if one does not feel self-confidence in that subject. Overall, the researcher found that roughly half of the "African-Americans," "European-Americans," and "Other Ethnicities" groups rated the people from their ethnicity groups to be "the same" when compared to other ethnicity groups, in terms of how good they are in physics. However, the researcher noticed that the very small (only 5 students) sample of Asian-Americans all rated themselves as either "Better" or "Much better" than people from other ethnicity groups, when it comes to being good at physics. However, as mentioned, the Asian-American sample was extremely small (5 students). In such a case, the descriptive statistics might not give an accurate picture of reality; however, they might serve to raise questions which could be studied further with larger sample sizes.

Another descriptive statistic that stood out to the researcher was that 30.8 % of African-Americans perceived their ethnicity group as being "worse" when compared to other ethnicity groups in terms of being good at physics. It must be mentioned that the sample size was small (13 students). Thus, 30.8 % represented 4 students out of 13. However, the information still is worth observing for people who truly wish to improve education in Mississippi and help all of our students succeed. The descriptive statistics perhaps raise questions which could be further investigated in the future. If students truly perceive themselves as comparing unfavorably with other groups in a certain subject, that would be important information for educators to know. Perhaps if teachers could truly find ways to show students that they can be proficient in the subject, the students could gain the confidence that might increase their performance.

Another aspect of self-efficacy which the researcher hoped to study was the students' views of how someone could become proficient at physics. In other words, are physicists born with greater mental gifts or do they develop those gifts through deep study? The researcher wanted to gain a small descriptive picture of how the 113 Physics II lab students viewed this debate. Two questions on the student survey forms that dealt with that concept were Question #11 (or Question #4 on the Instructor Survey Form) and Question #12 (or Question #5 on the Instructor Survey Form). The following two summary tables (Table 386 and Table 387) show the summary results for these two questions for three different sample groups of students, and the group of 16 physics instructors who were surveyed.

Table 386

Survey Answers Given by Various Samples of Physics Students (and Physicists) to Question #11[a] *of the Student Survey Form, "Choose which factor is* <u>*more*</u> *important in order for someone to become a good physicist?"*

Answer	Entire Group (N_{Total} = 113)	MS Natives (N_{MS} = 53)	Other Americans (N_A = 54)	Physics Instructors (N_{PI} = 16)
A person must be born with greater natural mental abilities for physics.	8.9 %	5.7 %	11.1 %	25.0 %
A person must spend many hours in personal study of physics.	46.0 %	41.5 %	46.3 %	18.8 %
They are of the same importance	45.1 %	52.8 %	42.6 %	50.0 %
No Answer was Chosen	NA	NA	NA	6.3 %

[a]This question (Question #11 on the student survey form) corresponds with Question #4 on the professor's survey form (see *Mississippi Physics Education: Instructor Survey Form*, in Appendix C).

Table 387

Survey Answers Given by Various Samples of Physics Students (and Physicists) to Question #12[a] *of the Student Survey Form, "Which statement best represents your opinion?"*

Answer	Entire Group (N_{Total} = 113)	MS Natives (N_{MS} = 53)	Other Americans (N_A = 54)	Physics Instructors (N_{PI} = 16)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	41.6 %	47.2 %	37.0 %	25.0 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	56.6 %	50.9 %	61.1 %	56.3 %
No Answer was Chosen	1.8 %	1.9 %	1.9 %	12.5 %
Other	NA	NA	NA	6.3 %

[a]This question (Question #12 on the student survey form) corresponds with Question #5 on the professor's survey form (see *Mississippi Physics Education: Instructor Survey Form*, in Appendix C). The only difference was the slight difference in boldface in the answer choices.

Upon looking at the descriptive statistics for the four groups which were compared in the two previous tables, it seems that a relatively small percentage of the lab students (8.9 % of the "Entire Group") believed that being born with greater natural mental abilities for physics is more important than spending many hours in personal study of physics when it comes to being good in physics. However, a large percentage (45.1 %) of the "Entire Group" of 113 lab students felt that it was approximately an equal mixture of natural-born mental ability and personal study. A large percentage (46.0%) of the “Entire Group” ((N_{Total} = 113) also felt that spending many hours in personal study of physics was more important than being born with greater natural-born mental abilities.

Of course, the researcher realizes that if a survey participant chose personal study as being more important than natural ability, this does not mean that he or she totally discounts the importance of natural ability; perhaps the survey participant just viewed studying as being even more important. The question just asked which factor they thought was *more* important. In the same way, one must realize that students who answered that “natural-born mental abilities” for physics were more important than the hours spent in personal study might also highly value the importance of personal study time. They are only answering which one they think is *more* important between the two choices. Thus, admittedly, it could be a very nebulous question.

However, the researcher wanted to somewhat quantify students’ and professors’ general opinions on this issue which was related to physics self-efficacy. The researcher was hoping to get a descriptive picture which might allow broad patterns to be seen, if they existed. Probably the most noticeable pattern from this portion of the survey results (at least of the three sample groups of students shown in the preceding two tables) was that relatively few students in the sample chose the option that rated natural-born mental abilities for physics as being more important than spending many hours in personal study of physics, when it comes to being a good physicist.

The researcher did notice that 25.0 % (or 4 out of 16) of the professors did, when forced to choose between the two, choose natural-born mental abilities as being more important than the hours spent in personal study. However, again, one must realize that this question forced one to choose between the two—or to simply say they were equal.

Perhaps other research instruments could be developed—such as those using Likert scales—which could more carefully define more precise gradations about the importance students or professors place on studying, on natural mental ability, and so forth. But, at least from the descriptive statistics of these samples, it seemed that the physics professors, to a higher percentage than the students, rated natural-born mental ability as being very important to the degree of even exceeding the importance of the hours which are spent in personal study.

Although 25.0 % of the professors did rate natural-born mental ability higher (when practically forced by the wording of the question to choose between the two), a large majority (68.6 %) of professors felt that natural-born mental ability was not more important than time spent in personal study in of physics. A high (50.0 %) percentage of the professors chose the answer choice that rated “natural-born mental abilities” and “hours spent in personal study” as being equally important, in becoming a good physicist. And, when forced to choose, 18.8 % of the professors answered that “hours spent in personal study” of physics was more important than natural-born mental abilities. However, again, the researcher emphasizes that this does not mean that these professors totally discount natural-born abilities. And, it does not mean that the portion who rated natural-born mental abilities as being more important totally discount the importance of personal study. The question was meant to somewhat quantify a very nebulous idea, so the resulting percentages should be understood in that context. They should not be taken to mean that the student or professor totally discounts the importance of one or the other of the answer choices.

The second summary table (see Table 387) of the two preceding tables shows some of the descriptive statistics for Question #12 on the Student Survey Form, which was Question #5 on the professor's survey form. The question asked students to choose whether or not the majority of people are born with the necessary mental capacity to become physicists when they reach adulthood. The question was also meant to quantify a nebulous concept. Perhaps another answer choice of "I am unsure" or "I do not know" should have been added. However, the researcher wanted to somewhat quantify what students and professors thought about this issue. The researcher was hoping that the descriptive statistics, though limited in usefulness, might help paint a basic picture (and possibly find broad patterns which could be investigated further).

Roughly speaking, a little over half (56.6 %) of the students in the "Entire Group" of 113 students believe that the majority of people are not born with the necessary mental capacity to become physicists when they reach adulthood. However, in such a small sample, one cannot speak very precisely of the percentages in the sense of being generalizable to greater populations. The basic pattern which seemed to emerge was that roughly half of the students who were surveyed felt that the majority of people are not born with the necessary mental ability to become physicists when they reach adulthood. And, very roughly speaking, the other half (41.6 %) of the students who were surveyed believed that the majority of people are born with the necessary capacity to become physicists when they reach adulthood.

Only 25.0 % of the 16 physics professors who were surveyed indicated that they believed that the majority of people are born with the necessary mental ability to become physicists when they reach adulthood. Roughly half (56.3 %) of the professors who were surveyed indicated that they believe that the majority of people are not born with the necessary mental ability to become physicists when they reach adulthood. It is worth noting, however, that 3 of the 16 physics professors (or 18.8 %) did not choose either of the two answer choices for that question (which was Question #12 on the Student Survey Form and Question #5 on the Instructor Survey Form). These three professors either chose no answer at all or else another answer was written in.

Questions #14 and #15 also touched upon concepts related to students' physics self-efficacy beliefs (i.e. their beliefs concerning whether or not they have the ability to be good at physics). For example, Question # 14 asked the survey participants to compare Mississippi students with students from other countries (in terms of rating how good they are in physics). In a similar manner, Question # 15 asked the survey participants to compare American students with students from other countries. Broadly speaking, the descriptive statistics reveal that at least for the four sample groups shown in the following summary table, most of the students rated Mississippians and American students to either be the same or worse at physics when compared to students from other countries. In general, it seems that the Mississippi students were rated to be worse than the general American students. However, overall, both the Mississippi students and the American students received ratings that if "averaged out" would place them as being rated worse than students from other countries.

And, it is important to notice that the sample of "Mississippi Natives" also (if all their answers were "averaged out") rated Mississippi students to compare somewhat unfavorably with other students from other countries. The group of "Other Americans" also compared themselves unfavorably to the students from other countries, if all answers were averaged out. But, again, the "Mississippi Natives" sample and the "Other Americans" sample were fairly small samples of roughly 50 or so students. Plus, the answer choices were only meant to descriptively measure the perceptions of students and professors rather than to compare students with hard test scores or other more analytical performance measures.

The following two summary tables (Table 388 and Table 389) show more precisely how each of the groups rated (or perceived) Mississippi students in terms of how they compare with students from other countries. The tables also show more precisely how the American students were rated (or perceived). The tables contain the descriptive statistics for four sample groups concerning these two questions (which would be Questions #14 and #15 on the Student Survey Form and Questions #7 and #8 on the Instructor Survey Form).

Table 388

Survey Answers Given by Various Samples of Physics Students (and Physicists) to Question #14[a] *of the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"*

Answer	Entire Group (N_{Total} = 113)	MS Natives (N_{MS} = 53)	Other Americans (N_A = 54)	Physics Instructors (N_{PI} = 16)
Much better	3.5 %	0.0 %	5.6 %	0.0 %
A little better	0.9 %	0.0 %	1.9 %	0.0 %
The same	30.1 %	28.3 %	33.3 %	31.3 %
A little worse	46.0 %	60.4 %	37.0 %	18.8 %
Much worse	15.9 %	7.6 %	18.5 %	31.3 %
No Answer was Chosen	3.5 %	3.8 %	3.7 %	18.8 %

Note. This summary table simplified the answer choices from the original wording of the answer choices (as they were written the survey forms). This was done to make the table easier to read and interpret. The original answer choices on the survey forms were written in complete sentences. For example, answer choice (a) was written as follows: "They are generally **much better** in physics than students from other countries." The researcher simplified this to "Much better" for the sake of this summary table. The other answer choices were simplified (in this table) in a similar manner. To see the precise way the answer choices were originally worded, see Question #14 of the *Mississippi Physics Education: Student Survey Form* (in Appendix C).

[a]This question (Question #14 on the student survey form) corresponds with Question #7 on the professor's survey form (see *Mississippi Physics Education: Instructor Survey Form*, in Appendix C).

Table 389

Survey Answers Given by Various Samples of Physics Students (and Physicists) to Question #15[a] *of the Student Survey Form, "Are American students good at physics when compared to students from other countries?"*

Answer	Entire Group (N_{Total} = 113)	MS Natives (N_{MS} = 53)	Other Americans (N_A = 54)	Physics Instructors (N_{PI} = 16)
Much better	4.4 %	1.9 %	5.6 %	0.0 %
A little better	8.0 %	5.7 %	11.1 %	0.0 %
The same	40.7 %	41.5 %	42.6 %	43.8 %
A little worse	41.6 %	45.3 %	35.2 %	25.0 %
Much worse	1.8 %	1.9 %	1.9 %	6.3 %
No Answer was Chosen	3.5 %	1.9 %	3.7 %	18.8 %
Other	1.9 %	1.9 %	NA	6.3 %

Note. This summary table simplified the answer choices from the original wording of the answer choices (as they were written the survey forms). This was done to make the table easier to read and interpret. The original answer choices on the survey forms were written in complete sentences. For example, answer choice (a) was written as follows: "They are generally **much better** in physics than students from other countries." The researcher simplified this to "Much better" for the sake of this summary table. The other answer choices were simplified (in this table) in a similar manner. To see the precise way the answer choices were originally worded, see Question #15 of the *Mississippi Physics Education: Student Survey Form* (in Appendix C).

[a]This question (Question #15 on the student survey form) corresponds with Question #8 on the professor's survey form (see *Mississippi Physics Education: Instructor Survey Form*, in Appendix C).

In a sense, the two questions, which were addressed in the two preceding tables, more properly might be thought to measure group self-perceptions. So, the descriptive statistics for these two questions really cannot give a picture of whether or not the students (or professors) feel that Mississippians (or, alternatively, Americans) *can* be good at physics. The descriptive statistics only describe whether or not the students (and professors) perceive Mississippians (or, alternatively, Americans) to *be* good at physics when compared at other students from other countries.

If the numbers in the preceding table are condensed a little more, it becomes easier to see that the descriptive statistics show that the Mississippi students were rated lower (descriptively speaking). One would notice that roughly 30 % of the survey participants (in each of the four groups) rated Mississippi students to be the same in physics as students from other countries; however, roughly 40 % of the survey participants (in each of the four groups) rated American students to be the same in physics as students from other countries. One would notice, for example, that if looking at the Entire Group (N_{Total} = 113) of Physics II lab students, approximately 62 % of them rated Mississippi students to be a little worse or much worse in physics than students from other countries; whereas, this same sample (Entire Group) rated roughly 43 % of American students to be a little worse or much worse in physics than students from other countries.

As far as self-perceptions go, 0 % of the sample of "Mississippi Natives" (N_{MS} = 53) had the opinion that Mississippi students were either much better or a little better in physics than students from other countries; whereas, approximately 68 % of the sample of "Mississippi Natives" students felt that Mississippi students were generally either a little worse or much worse in physics than students from other countries.

When the self-perceptions of the "Other Americans" (i.e. Americans from states other than MS) physics students were looked at more closely, it was found that roughly 17 % of them felt that American students were either much better or a little better in physics than students from other countries; and roughly 37 % of them felt that American students were either a little worse or much worse in physics than students from other countries.

If the opinions of the 16 physics professors (who were surveyed) were consulted on this issue (see Table 388 and Table 389), one would find that 0 % of them perceived either the Mississippi students or the American students to be either much better or a little better in physics than students from other countries. Some of them (roughly 31 %) felt that the Mississippi students were the same in physics as students from other countries; whereas roughly 44 % of them felt that American students were the same in physics as students from other countries. However, roughly 50 % of the physics professors felt that Mississippi students were either a little worse or much worse in physics than students from other countries; whereas, roughly 31 % of the physics professors felt that American students were either a little worse or much worse in physics than students from other countries. It is also worth noting that roughly 20 to 25 % of the professors had “Other” answers on these two questions.

It is important to realize that the statistics are descriptive statistics which paint a picture of what might be happening; at times, they can reveal patterns which might exist. Such statistics are not meant to nail down the precision of a certain comparison; rather, they are meant to help understand a broad pattern, if possible. The sample sizes are not huge. Indeed, the sample size of the “Physics Instructors Surveyed” group was just 16; this means that any percentage comparisons with their survey results are much shakier (i.e. more statistically uncertain). Nevertheless, when looking at the comparative answers of the sample groups in the above summary table, it seems that a basic rather consistent pattern emerges. The pattern that emerges from these descriptive statistics paints a picture which portrays both Mississippi students and other American students as being perceived to compare somewhat unfavorably with students from other countries, when it comes to physics. And, when it comes to physics, the Mississippi students are apparently perceived (even by themselves) as comparing unfavorably to an even greater degree than the other American students, when compared with students from other countries.

Another question on the survey forms was more precisely designed to better understand how students (and professors) perceive physics ability as it is related to gender. The question that most specifically addressed this issue was Question #16 on the Student Survey Form (which was Question # 9 on the Instructor Survey Form). An important area of research, which is related to the concept of physics self-efficacy, deals with the differences between how males and females perceive their own ability in science (and physics).

It is well known, in the field of physics and science education, that there are fewer females in the physics professions. Many research projects are conducted, and many articles are written in order to better understand why it seems that there are so few women involved in the science fields, overall. This particular survey question dealt more specifically with how the students perceive themselves and their ability in science. The summary descriptive statistics (for four different sample groups) are shown in the table which follows. The descriptive statistics of the “Entire Group” (113 Physics II lab students), the “Males” group (72 Physics II lab students), the “Females” group (41 Physics II lab students), and the “Physics Instructors” (16 physicists who work or worked at various universities in Mississippi) are compared in the following table.

Table 390

Survey Answers Given by Various Samples of Physics Students (and Physicists) to Question #16[a] *of the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender?"*

Answer	Entire Group (N_{Total} = 113)	Males (N_M = 72)	Females (N_f = 41)	Physics Instructors (N_{PI} = 16)
Females naturally have better mental ability for physics than males.	1.8 %	2.8%	0.0 %	0.0 %
Males naturally have better mental ability for physics than females.	39.8 %	47.2 %	26.8 %	6.3 %
Females and males have the same mental ability for physics.	56.6 %	48.6 %	70.7 %	81.3 %
No Answer was Chosen	1.8 %	1.4 %	2.4 %	6.3 %
Other	NA	NA	NA	6.3 %

[a]This question (Question #16 on the student survey form) corresponds with Question #9 on the professor's survey form (see *Mississippi Physics Education: Instructor Survey Form*, in Appendix C).

The survey results (shown in the summary table above) show that for every group shown in the table above, the highest percentage answered that "females and males have the same mental ability for physics". However, a fairly large percentages of students rated males as having "better mental ability for physics than females." Indeed, a high percentage (47.2 %) of the 72 males in the "Males" group rated males as having "better mental ability for physics than females." In contrast, very few students rated females as having "better mental ability for physics than males." The males, more often than the females, were rated as having "better mental ability for physics." Interestingly enough, 26.8 % of the females rated the males as having “better mental ability for physics than females.” This indicates that a weaker physics self-efficacy level might be operating among this subset of female students. In other words, some of them might have low levels of confidence in their mental ability to succeed in physics. One would hypothesize that this could have a negative impact on their ability to stay motivated to study physics.

If one examines the descriptive statistics of the professors’ answers to that question, one sees that the professors, with the highest percentage of any of the four groups compared in the summary table, rated females and males to have the same mental ability for physics. One must realize, also, that physics professors are arguably in one of the best positions to evaluate this particular question. Many of them have taught hundreds (or maybe even thousands) of students over the years, and have thus had an opportunity to closely evaluate the physics work and physics ability of both males and females. And, a high percentage (81.3 %) of these professors rated females and males to have the same mental ability for physics. (Plus, another 12.5 % of professors, in other words 2 of the 16, left the question blank or wrote in another answer, such as “I don’t know”). Overall, only one physics professor, out of the 16 who were surveyed, rated males as having better natural mental ability for physics than females. The following figure (see Figure 7) illustrates these findings with a graphical representation.

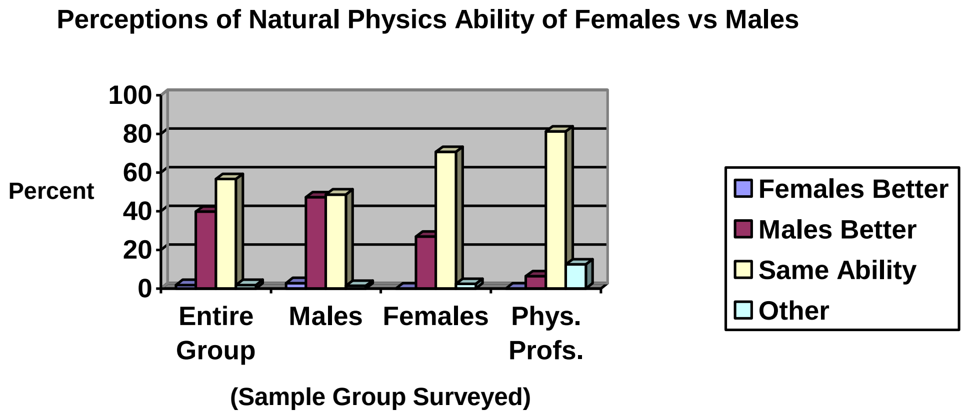

Figure 7. The graph above illustrates the answers chosen by each sample group. The four groups shown are the "Entire Group" (N_{Total} = 113), the "Males" group (N_M = 72), the "Females" group (N_f = 41), and the "Physics Professors Surveyed" group (N_{PI} = 16). The question they were answering was Question #16 on the Student Survey Form (or Question #9 on the Instructor Survey Form). This question asked for their opinion of how physics ability is affected by gender.

Research question #7.

Do physics students at the University of Mississippi have any commonalities in attitudes toward their self-efficacy beliefs in physics as students from other states or countries?

The surveys which were conducted as part of this research revealed that for the sample which was surveyed (113 Physics II lab students at the University of Mississippi), the 26.8 % of the females in the sample viewed males as having naturally better mental abilities in physics than females. This result is perhaps in alignment with findings mentioned by Kessels et al (2006) in an article in the *British Journal of Educational Psychology (2006),* 76 (pp. 761-780). According to Kessels et.al (2006),

> Comparisons revealed that girls hold a more negative implicit attitude toward physics than boys. Further, girls associated physics with difficulty more strongly than boys did and, interestingly, they also had stronger associations between masculinity and physics than boys did. (p. 774)

Perhaps one explanation for why some girls (26.8 %) rated boys to naturally have better mental ability for physics was due to the fact some of the girls view physics to be a boys' subject. Kessels et al. (2006), referencing several other authors, mentioned that studies have found that math and science "subjects have a connotation as masculine" or boys' subjects (p. 762). Perhaps this concept can partially explain why some females (26.8 %) in this particular research at University of Mississippi would rate males as having naturally better mental ability in physics than females. Yet, the researcher feels that it would be a conjecture (which this particular dissertation does not have the data to support) for one to fully attribute the 26.8 % as being highly related to females viewing physics as a masculine subject.

The researcher, wishing to investigate another possible similarity between the research at the University of Mississippi and the findings of other researchers, wished to investigate how difficult the female sample viewed college physics to be (compared to how difficult the male sample viewed college physics to be). For, another point which Kessels et al. (2006) mentioned, in the previous material quoted above, was that girls "associated physics with difficulty more strongly than boys" (p. 774).

However, upon reviewing the survey results of this research project at the University of Mississippi, it was found that although many students (both males and females) found college physics to be a difficult subject, there was not much difference (according to the descriptive statistics) of how difficult the females perceived their college physics courses to be compared to how difficult the males perceived the college physics courses to be.

For example, Question #7 on the Student Survey Form asked students to answer the question, “How difficult were your college physics courses?” The answer choices available were: “Very easy,” “Easy,” “Medium Difficulty,” “Difficult,” “Very Difficult,” and “Not Applicable.” With this array of choices, 58.5 % of the females (N_f = 41) chose either “Difficult” or “Very Difficult” to describe their college physics courses. However, when looking at the sample of 72 males (N_m = 72), a similar percentage (55.6 %) rated their college physics courses as either “”Difficult” or “Very Difficult”. The picture painted by the descriptive statistics, in this case, implies that for this sample of students who were surveyed, there was not an appreciable difference between the percentage of males and females who perceived their college physics courses to be either “Difficult” or “Very Difficult,” as measured by the survey results to Question #7 on the Student Survey Form.

Furthermore, when looking at the self-evaluation grades (of males vs. females) which the students gave themselves when answering survey Question #5 on the Student Survey Form, 53.7 % of the 41 females described their college physics performance with an “A”; whereas, 52.8 % of the 72 males described their college physics performance with an “A.” These percentages are remarkably similar. (The researcher must again mention, for the sake of clarity, that these students were Physics II lab students, and so they had already taken—and presumably passed—Physics I. So, it is important to keep in mind that when these students are describing their college physics performance, these are students who have presumably already passed Physics I. This is a selective factor which has selected them out of the general population of students.)

Another aspect of this research project (at the University of Mississippi) which might shed light on self-efficacy beliefs (within this context) was fact that 46.3 % of the females ($N_f = 41$) in the sample rated themselves as either “Excellent” or “Above Average” in physics (39.0 % listed “Above Average” and 7.3 % listed "Excellent"). This was in answer to Question #9 on the Student Survey Form, which asked them to rate how good they are in physics. On the same question, 54.1 % of the sample of males ($N_m = 72$) answered with either “Excellent” or “Above Average” (with 45.8 % listing “Above Average” and 8.3 % listing "Excellent"). These descriptive statistics imply that many females (as well as males) do see themselves as being proficient in physics—although not many see themselves as being “Excellent” in physics. But, these statistics (especially with the relatively small sample sizes) do not show much of a difference between how females and males view themselves (concerning whether or not they are good at physics).

Ultimately, though, the fact that 26.8 % of the females who were surveyed for this research project (at Univ. of Miss.) believed that males have better natural ability for physics than females is a point which might be somewhat in alignment with some of the findings mentioned by Kessels et al. (2006) concerning the perception (of some females) of physics as a masculine subject. The Kessels et al. (2006) study, which was published in *British Journal of Educational Psychology (2006),* 76 (pp. 761-780), could apparently be viewed as a study with international implications, and indeed Ursula Kessels, Melanie

Rau, and Bettina Hannover were apparently associated with the Freie Universitaet Berlin, Germany.

Thus, there is at a small bit of evidence (worth investigating further) that implies that some females in the research project at the University of Mississippi have certain self-efficacy beliefs in common with females in other parts of the world. However, the researcher emphasizes again that this is very much a conjecture, and that it very much would need to be researched more deeply and with larger sample sizes before one could speak with a greater degree of certainty.

Research question #8.

Do physics students at the University of Mississippi enjoy the subject of physics? Do their answers to this question show commonalities with the views of students from other states or countries (as documented in the literature)?

The researcher performed a "Yes/No/Somewhat" analysis on the written answers which the students provided to Question #17 on the *Mississippi Physics Education: Student Survey Form* (see Appendix C). Question #17 asked the students, "Do you enjoy the subject of physics? Explain." The researcher then carefully observed each answer which was provided (by the 113 students who were surveyed), and then the researcher assigned a "Y" (yes), "S" (somewhat), or "N" (no) beside each answer (depending on which classification theme the answer best fit). The researcher will again display the results of that analysis in a table. The same table (with a slightly more explanatory title) was shown following the written responses of the students which were typed up.

However, for the sake of clarity in the answer to this research question, the answers (to the first part of Question #17) of the Student Survey Form are shown again in Table 391 below.

Table 391

"*Do you enjoy the subject of physics?*

Thematic Category	Number of Physics Students	% of Sample (N_{Total} = 113)
Yes	55	48.7 %
No	27	23.9 %
Somewhat	28	24.8 %
No Answer was Given	3	2.7 %

The preceding summary table illustrates that roughly half (48.7 %) of the 113 Physics II lab students indicated (on the Student Survey Form) that they do enjoy the subject of physics. Another quarter (24.8 %) of the students who were surveyed indicated that they "somewhat" enjoy physics. The remaining quarter (actually 23.9 %, to be more precise) of students indicated that they do not enjoy physics.

This particular sample of 113 Physics II lab students consisted of 5 separate labs separated by almost a year in time. Two of the labs were surveyed in July of 2012, and the other three labs were surveyed in April of 2013. Plus, each lab was separate from the others. Overall, it appears that these 113 Physics II lab students had relatively favorable views of physics, because nearly half of them indicated that they enjoyed physics.

Another quarter of the sample “somewhat” enjoyed it. However, the researcher really must say that the students had “relatively favorable” views of physics, because the researcher does not have any other academic subjects to measure this sample against, and the term "somewhat enjoy physics" could be very nebulous. Hence, there is much uncertainty with saying that the students had relatively favorable views of physics.

However, according to the article *How Choosing Science depends on Students' Individual Fit to 'Science Culture'* (Taconis & Kessels, 2006, p. 1120), a study of 54 Dutch ninth-grade students was performed in which students were asked to rank 11 school subjects according to their personal preference. The results of analyzing the rankings showed that “physics and chemistry were the least popular” (Taconis & Kessels, 2006, p. 1121). Indeed, according to Taconis and Kessels (p. 1121), “Physics, in particular, was significantly less popular than all other subjects.”

Yet, the finding in the research study at the University of Mississippi (among Physics II lab students) would suggest that negative views of physics are not so prevalent. However, the researcher really does not have a good “measuring stick” (such as a similar questionnaire for another subject) to measure the answers against. But, the observation that only 23.9 % of the students clearly indicated that they did not enjoy physics leads one to believe that the results of this research study (among college-level Physics II lab students) definitely did not seem to be in alignment with the Taconis and Kessels study. Yet, then again, one must mention that there were great differences in the sample of students who were surveyed--so in that sense, the studies are not comparable.

The sample of 113 students in this University of Mississippi study were Physics II lab students who had already been selected out of the general population of students.

They had already (presumably) successfully passed college-level Physics I. Thus, one can suspect that these were some of the better students, and thus they perhaps had more positive views of physics than apparently the students (54 Dutch 9th grade students) in the Taconis & Kessels (2006) study did. Also, the Taconis & Kessels study used very different instruments and statistics to measure (or rank) the popularity of physics. Thus, the UM researcher (Paul Rogers) cannot really say which percentage of the students in the Taconis & Kessels study enjoyed the subject of physics. It simply seems to be implied that not a high percentage of students in the Taconis & Kessels study did enjoy physics since it was "significantly less popular than all other subjects," according to Taconis & Kessels (p. 1121).

Research question #9.

What are the reasons that students at the University of Mississippi give for pursuing (or not pursuing) physics degrees?

The Student Survey Form contained two questions (Question #18 and Questions #19) which asked the students for the reasons why they did not major in physics (or alternatively, why they did choose to major in physics). The researcher typed up all the responses of the students, and the individual responses of each student was included in this dissertation. A summary table, which analyzed the responses in terms of themes, was also shown just below the students' written responses.

Of the 113 students who were in the sample of Physics II lab students, 4 students indicated that they were physics majors. The following summary table (Table 392) shows the reasons they listed for choosing to major in physics.

Table 392

Broad Themes from the Written Responses of the Four Physics Majors who Answered Question # 19 on the Student Survey Form

Why did you choose to major in physics?
* I enjoy math. (1)
* I enjoy problem solving. (2)
* It will be beneficial for me in my pursuit of a career in medicine. (2)
* A degree in physics can lead to a wide variety of careers. (2)
* Physics will set me apart from engineering students when I apply to grad school.(1)
* Physics represents a method of thinking "outside of the box" (i.e. in an independent, different, and creative way). (1)

The preceding table shows that two students indicated that the fact that they enjoyed problem solving was an important reason for why they chose to major in physics. Also high on the list of reasons was the perception that physics would be beneficial to them in their pursuit of a medical career. Two students also indicated, in their responses, that they felt that a degree in physics could lead to a wide variety of careers.

The next summary table (Table 393) summarizes the written responses of the students to Question #18 which asks them to explain why they chose not major in physics. A larger, more exhaustive theme table (see Table 365) is shown directly following the written responses of the students; it shows many more reasons that the students gave. However, the following summary table is a further condensed version which shows the most common broad themes that emerged from the analysis of the students' answers to why they chose not to major in physics. The number in parentheses next to the statement shows how many students gave an answer which had elements that fit that particular theme.

Table 393

Top Ten Most Commonly Indicated Broad Themes for Why The Students Chose not to Major in Physics, from the Written Responses of the 113 Physics Lab II Students to Question # 18 on the Student Survey Form

Why did you choose not to major in physics?
* I am more interested in another subject, major, or profession. (44)
* I dislike physics or don't enjoy it. (15)
* I am not interested in physics. (14)
* Physics is difficult. (8)
* Career/job prospects are better in another field. (7)
* I chose a major that would be better for preparing me for a career in medicine. (5)
* I am not interested in the types of jobs physicists do. (4)
* I prefer application to theory. (3)
* I dislike the math that would be required. (3)
* I did not know much about physics. (3)

The most commonly listed reasons tend to be the more general reasons that many students would mention—and thus they show up more strongly when one is tallying up the theme totals. For example, many students indicated that they were more interested in another subject—and this naturally adds up to be the most common item on the list, if many students indicate this. Some of the students (15 in this case) indicated that they dislike physics. Another large category of students indicated that they were not interested in physics. The fourth item on the list is that students dislike physics because it is difficult.

Many articles in the literature have documented that physics is considered to be a difficult subject by students. According to Ornek et al. (2008) (who were writing about a study done with a group of students, TAs, and faculty), the “Faculty members, TAs, and students all agree that physics is difficult” (p. 32). Ornek et al. went on to state, “Faculty members and TAs agree that physics requires good mathematics and cannot be learned without mathematics background” (p. 33-34).

The fifth item on the list of reasons why students did not choose to major in physics was that career prospects are better in another field. The sixth most popular choice was that the students chose another major because it was better for preparing them for a career in medicine. There were other reasons mentioned, as well, such as the fact that some students prefer application to theory; and that some students dislike the math. The complete, literal written responses of the students are included in Appendix D. The written responses show the full context of how the students answered each short-answer question on the Student Survey Form.

The researcher also conducted an interview with 10 physics students at the University of Mississippi. During the interview, the researcher tried to generally ask questions according to the *Qualitative Survey Form: (For Interview with Students)* (see Appendix C). This interview form also had a question on it which asked the students whether or not they majored in physics. If they said that they did not major in physics, then they were asked why they chose not to major in physics. They gave a variety of responses during the interview. The full responses can be seen by reviewing the complete interview transcripts which are included in Appendix E. However, in the table below, the responses which were mentioned most commonly are shown.

The researcher, in order to develop this table, had to analyze the students' interview transcripts, and then put their answers into common themes or categories. The number in parentheses (in the table below) shows the number of students who mentioned that particular theme or category. None of these students who participated in the interviews indicated that they were physics majors. Thus, the table below shows reasons that the students gave during the interview for why they chose not to major in physics.

Table 394

Most Commonly Mentioned Themes (from Main Answers of 10 Physics Students who were Interviewed: Question 2(b) on Interview Form with Students

Why did you choose not to major in physics?
*I am attracted to the practical applications associated with an engineering major. (4)
*I am more interested in another subject. (3)
*I felt that another major was better designed to help me get into medical school than a major in physics would be. (2)
*My engineering major fits well with my military career plans. (2)
*I am more interested in biology. (2)
*I am more interested in applications rather than theories. (2)

The 10 students who were involved in the interview had volunteered to conduct the interview when the researcher asked for volunteers while conducting the student surveys--or in some cases, they might have volunteered later (after they finished their lab) since the researcher mentioned that he would wait outside the lab for any volunteers that would be willing to conduct an interview. Thus, it was a convenience sample rather than truly representative sample of the Physics II lab general student population. In the opinion of the researcher, the students who agreed to be interviewed seemed to likely be some of the better physics students—at least, that was the general impression they gave to the researcher (who has taught many years and is familiar with students of all types). However, the researcher cannot say for sure that they were all good students. But, overall, in the opinion of the researcher, there is a high likelihood that many of them were good students.

The answers in the preceding table (Table 394) are only the answers which were mentioned by more than one student. There were other reasons that were given, but they are not shown in the table. One can consult the full transcripts of the interviews for the other reasons.

The researcher noticed, during the course of conducting this research, that many students seem to be interested in "applications." Also, another very common theme that emerged, in the course of this research, is that students are very interested in the medical field—in biology, in medicines, in the human body, and so forth. And, it appears that a common thing for students to do is to choose a major that gives them a good chance to get into medical school, while still providing job opportunities if they happen not to get into medical school.

Thus, if physicists could somehow continue to show students the relevance of majoring in physics while in pursuit of a career in the medical field—and to do everything possible to truly make the physics major applicable to careers in the medical field—this might greatly increase the students' interest in physics. It might increase the number of students from the state who choose to major in physics. Physics departments might see an increased quantity of talented students from the local area who are preparing for careers in medicine. And, as a side benefit, some of these talented students might choose to pursue a career in pure physics (at the graduate level) rather than going on into the professional levels of the medical field.

Research question #10.

Are there any similarities between the physics self-efficacy views of physics instructors and the physics self-efficacy views of students at the University of Mississippi?

On the student survey form, all 16 multiple-choice questions were in a section which was labeled "Part II: Physics Self-Efficacy." However, Questions #8-12 and Questions #14-16 were, arguably, the questions which more closely fell into the category of addressing self-efficacy, in the sense of measuring students' beliefs about their ability to be good at physics. Although the professors' survey form (Instructor Survey Form) did not contain all of these questions, it did contain some of them. On the Instructor Survey Form, Questions #4-5, and Questions #7-9 were very similar to (or in most cases, the same as) Questions #11-12 and Questions #14-16 from the student survey form. Thus, the answers the professors gave to these particular questions (relating to self-efficacy views) can be compared with the answers the students gave. These comparisons were already made when the researcher was addressing Research Question #6 which dealt with students' self-efficacy (or belief in their own ability to be competent at physics). The summary results of those comparisons are shown again here (in Table 395), but in a slightly more simplified form which shows only the comparison of the survey answers of the 16 professors matched up against the survey answers of the entire group of Physics II lab students.

Table 395

Comparison of Physics Professors to Entire Group of Physics Students for Question #11[a] *of the Student Survey Form, "Choose which factor is more important in order for someone to become a good physicist?"*

Answer	Entire Group (N_{Total} = 113)	Physics Instructors (N_{PI} = 16)
A person must be born with greater natural mental abilities for physics.	8.9 %	25.0 %
A person must spend many hours in personal study of physics.	46.0 %	18.8 %
They are of the same importance.	45.1 %	50.0 %
No Answer was Chosen	NA	6.3 %

[a]This question (Question #11 on the student survey form) corresponds with Question #4 on the professor's survey form (see *Mississippi Physics Education: Instructor Survey Form*, in Appendix C).

The sample size of the "Physics Instructors" group is small (16 physics professors or research physicists). The descriptive statistics only paint a picture for this particular sample, but they do not (on the surface) prove statistical significance of the proportions displayed in the percentages. At a glance—for these two sample groups—it appears that the physics professors place a slightly stronger emphasis on the importance of natural-born mental abilities for physics than did the “Entire Group” of Physics II lab students. But again, we can only say that about these two sample groups which were being compared. And, it is emphasized again that these are descriptive statistics which are meant to portray a pattern, but not to nail down precisely the uncertainty or certainty of the statistical significance.

Also, it is important again to realize that the wording of the question as stated on the survey form forced the survey participant to choose between two or three choices. Thus, the fact that a professor—when forced to choose—placed “natural-born mental ability” as ranking ahead of “hours spent in personal study” does not mean that the professor does not value the hours spent in personal study. And, in a similar manner, the fact that a professor ranked “hours spent in personal study” ahead of “natural-born mental ability” does not mean that the professor does not value “natural-born mental ability”. The students faced the same dilemma when answering such survey questions. This particular comparison (for Question #11) was already discussed somewhat in the discussion of Research Question #6.

The same dilemma (with being forced to choose between two answers) occurred in the question shown in the table which follows. The questions were written this way, rather than with a numeric rating scale, so that the researcher could attempt to more strongly quantify the answers. It was hoped that this would help the researcher (and others) understand how students (or professors) viewed intelligence as it relates to physics.

Table 396

Comparison of Physics Professors to Entire Group of Physics Students for Question #12[a] *of the Student Survey Form, "Which statement best represents your opinion?"*

Answer	Entire Group (N_{Total} = 113)	Physics Instructors (N_{PI} = 16)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	41.6 %	25.0 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	56.6 %	56.3 %
No Answer was Chosen	1.8 %	12.5 %
Other	NA	6.3 %

[a]This question (Question #12 on the student survey form) corresponds with Question #5 on the professor's survey form (see *Mississippi Physics Education: Instructor Survey Form*, in Appendix C). The only difference was the slight difference in boldface in the answer choices.

The descriptive statistics in the preceding table show that for these samples, roughly half of the professor group and roughly half of the student group (Physics II Lab students) indicated that they believe that the majority of people are not born with the necessary mental capacity to become physicists when they reach adulthood. A lower proportion (one-fourth) of the professor group indicated that the majority of people are born with the necessary mental capacity to become physicists when they reach adulthood. Roughly 40 % of the entire student group felt that the majority of people are born with the necessary mental capacity to become physicists when they reach adulthood.

The next two tables compare the views of the entire group of Physics II Lab students with the views of the physics professors (or research physicists) on the question of whether or not Mississippi students (and American Students) are good at physics when compared to students from other countries. These summary results, and many of the comparisons, were already discussed in the discussion of Research Question #6. However, the results tables are shown below in a slightly more simplified form which just shows the comparison of the professors (i.e. the “Physics Instructors Surveyed” group) and the 113 Physics II lab students (i.e. the “Entire Group” sample).

Table 397

Comparison of Physics Professors to Entire Group for Question #14[a] *of the Student Survey Form, “Are Mississippi students good at physics when compared to students from other countries?”*

Answer	Entire Group (N_{Total} = 113)	Physics Instructors (N_{PI} = 16)
Much better	3.5 %	0.0 %
A little better	0.9 %	0.0 %
The same	30.1 %	31.3 %
A little worse	46.0 %	18.8 %
Much worse	15.9 %	31.3 %
No Answer was Chosen	3.5 %	18.8 %

Note. This summary table simplified the answer choices from the original wording of the answer choices (as they were written the survey forms). This was done to make the table easier to read and interpret. The original answer choices on the survey forms were written in complete sentences. For example, answer choice (a) was written as follows: “They are generally **much better** in physics than students from other countries.” The researcher simplified this to “Much better” for the sake of this summary table. The other answer choices were simplified (in this table) in a similar manner. To see the precise way the answer choices were originally worded, see Question #14 of the *Mississippi Physics Education: Student Survey Form* (in Appendix C).
[a]This question (Question #14 on the student survey form) corresponds with Question #7 on the professor’s survey form (see *Mississippi Physics Education: Instructor Survey Form*, in Appendix C).

The main idea portrayed by the descriptive statistics in the above table is that extremely few students (and no professors) rated Mississippi students as being either much better or a little better in physics than students from other countries. Also, in connection with this idea was the observation that large proportions (roughly 60 %) of the lab students and a large proportion (roughly 50 %) of the professors rated Mississippi students to be either a little worse or much worse in physics than students from other countries. Roughly 30 % of both the students and the professors rated Mississippi students to be the same in physics as student from other countries.

The following table (Table 398) shows the descriptive statistics for the survey results to a very similar question about American students, in general. It was meant to somewhat provide a comparison of Mississippi students with the general American student. The descriptive statistics for the samples which were surveyed show that slightly over 40 %) of the lab students rated American students to be either a little worse or much worse in physics than students from other countries. Roughly 30 % of the professors ranked American students as being either a little worse or much worse in physics than students from other countries. Roughly 40 % of both the students and the professors rated American students to be the same in physics as students from other countries.

These statistics are descriptive statistics which mainly serve to portray broad patterns rather than to precisely determine the uncertainty of each percentage (or the confidence level) of various conclusions. But, it appears that for these sample groups in the survey, the Mississippi students were ranked below American students, in terms of being good at physics. And, both the Mississippi group and the American group were ranked below the students who come from other countries, in terms of being good at physics. However, it is important to note that noticeable percentages of both the students and the professors rated the Mississippi students and the American students to be the same in physics as students from other countries. The researcher did find it to be interesting that the proportions of Physics Lab II students and Physics Professors who answered “The same” was so similar (in both the table dealing with Mississippi students and the table dealing with American students). The descriptive statistics for the question dealing with the American physics students is shown in the table below.

Table 398

Comparison of Physics Professors to Entire Group of Physics Students for Question #15[a] *of the Student Survey Form, “Are American students good at physics when compared to students from other countries?”*

Answer	Entire Group (N_{Total} = 113)	Physics Instructors (N_{PI} = 16)
Much better	4.4 %	0.0 %
A little better	8.0 %	0.0 %
The same	40.7 %	43.8 %
A little worse	41.6 %	25.0 %
Much worse	1.8 %	6.3 %
No Answer was Chosen	3.5 %	18.8 %
Other	1.9 %	6.3 %

Note. This summary table simplified the answer choices from the original wording of the answer choices (as they were written the survey forms). This was done to make the table easier to read and interpret. The original answer choices on the survey forms were written in complete sentences. For example, answer choice (a) was written as follows: “They are generally **much better** in physics than students from other countries.” The researcher simplified this to “Much better” for the sake of this summary table. The other answer choices were simplified (in this table) in a similar manner. To see the precise way the answer choices were originally worded, see Question #15 of the *Mississippi Physics Education: Student Survey Form* (in Appendix C).

[a]This question (Question #15 on the student survey form) corresponds with Question #8 on the professor’s survey form (see *Mississippi Physics Education: Instructor Survey Form*, in Appendix C).

The last question on the survey form addressed self-efficacy in the sense of trying to understand how males and females view their own natural physics ability. This question was also discussed with some depth in the discussion of Research Question #6. The descriptive statistics in the table below again show the comparison between the entire group of Physics II lab students and the physics professors (or research physicists).

Table 399

Comparison of Physics Professors to Entire Group of Physics Students for Question #16[a] *of the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender?"*

Answer	Entire Group (N_{Total} = 113)	Physics Instructors (N_{PI} = 16)
Females naturally have better mental ability for physics than males.	1.8 %	0.0 %
Males naturally have better mental ability for physics than females.	39.8 %	6.3 %
Females and males have the same mental ability for physics.	56.6 %	81.3 %
No Answer was Chosen	1.8 %	6.3 %
Other	NA	6.3 %

[a]This question (Question #16 on the student survey form) corresponds with Question #9 on the professor's survey form (see *Mississippi Physics Education: Instructor Survey Form*, in Appendix C).

The most noticeable descriptive statistic when comparing the views of the physics professors to the views of the entire group of Physics II lab students, is that a higher percentage (over 80 %) of the physics professors indicated that they felt that females and males have the same mental ability for physics. As was mentioned earlier in the discussion of Research Question #6, the physics professors are perhaps some of the best people in the state to assess this question, because they have taught hundreds (and, in some cases, thousands) of physics students. They have extensively dealt with grading papers, grading tests, and reviewing students' work. Overall, it can be said that very few of the physics professors in the sample indicated that either males or females have an advantage when it comes to mental ability for physics.

To close the discussion on the self-efficacy comparison between the professors and the students, it must be mentioned that the questions dealing with physics self-efficacy were, for the most part, written in such a way as to measure the students' physics self-efficacy rather than the professors' physics self-efficacy. The self-efficacy questions were primarily meant to determine how the students felt about their physics ability (or how they felt that someone can become good in physics).

Yet, although the self-efficacy questions were written mostly to address the students' views, the comparisons between the students' views and the professors' views might highlight important points which could be studied by future researchers. Plus, some of the questions do have applications for understanding even the professors' physics self-efficacy views. For example, some of the more general questions deal with how someone gets good at physics, and whether or not the mental ability for physics is more of a natural gift or more of something that is finely developed through study—or both. The answers the professors gave to some of these questions could give us a glimpse into issues which might relate to their physics self-efficacy views. The sample size of the professor group which was surveyed was small (16 professors). Yet, the researcher is unaware of any other such detailed study of physics professors' views being conducted in Mississippi. Thus, the researcher hopes that even though the sample size of the professor group was relatively small, the descriptive statistics will still be valuable and useful information which could possibly highlight areas of potential research in physics education. Plus, they provide a sort of snapshot of Mississippi physics as it exists in the early 21st Century. This could prove to be interesting to historians, especially those historians who are interested in the history of education.

Research question #11.

What are the opinions of physics professors at University of Mississippi concerning the problems that are faced by Mississippi students in physics?

During the course of this research project, the researcher interviewed 17 physics professors or research physicists from different universities in the state of Mississippi. Five of the physicists (out of the 17) were classified as native-born Mississippians (although one of the five moved here as an infant); their opinions are discussed in a different summary table. Twelve of the physicists (out of the 17) were not native-born Mississippians, but most of them are now Mississippians as they live and work in the state of Mississippi; all of this group of twelve physicists (who were not native-born Mississippians) work or once worked at the University of Mississippi. Of course, the researcher is unsure of their actual "official" residence statuses. But, in an informal sense, they are Mississippians in the sense that they, as far as the researcher knows, live in the state and definitely have worked in the state of Mississippi. But, the researcher is rather ignorant of the legal restrictions surrounding the change of citizenship—or the gaining of a dual citizenship. Thus, the researcher cannot say for certain that all of the professors have official residence status as Mississippi residents. Plus, some of them might be emeritus professors—and so they might live in other states or countries, now. But, regardless of their official residence status, the professors who were interviewed work (or have worked) in the state of Mississippi as physics professors or as research physicists. Thus, they are familiar with many aspects related to physics in the state of Mississippi. As a group, they are highly qualified to speak about the topic of physics in the state of Mississippi.

The following table (see Table 400) shows some of the main categories and themes that the researcher condensed from their interviews. Some of the themes were left in a rather "long-form," because the answers were often so unique that they were hard to really condense into common themes, especially since only 12 physicists were being interviewed for this portion of the study. Thus, in general, there is a "long-form" theme which came from the instructor's "main answer" to the question. The researcher did not want to lose valuable information which was provided, nor did he want to somehow distort the meaning of the answers in cases where they were hard to classify into another common theme. However, if the researcher could clearly put the answers into definite categories, he tried to do so. Thus, there is also a "short-form" theme (at the beginning) which lists every broad theme that was referenced by more than one professor during the course of the interview.

In Table 400, the number in the parentheses beside each statement (or theme) shows how many professors referenced that particular theme. The question which is shown is Question #1 from the *Qualitative Survey Form (Interview with Physics*

Instructors) which is included in Appendix C. In their answers to this question #1 of the interview, information is provided by the professors concerning some of the problems Mississippi students face in physics. (To see the full context and phrasing of all the questions and answers, consult the full transcripts of the professors' interviews which are included in this research study.)

Table 400

Are Mississippi Students well-prepared for graduate level physics? Some Commonly Mentioned Themes from Main Answers of the 12 Professors who were Interviewed (Interview Question #1)

Question 1: In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places?
*Yes.(3)
*No.(7)
*It is difficult to gauge; it is hard to know for sure.(6)
*There are some Mississippi graduate students who seem to be reasonably well-prepared; there are some Mississippi graduate students who do well. (5)
*We do not have very many students from Mississippi in the graduate program for physics.(2)
*No, I don't think so; in general, they are not really that well-prepared; one reason for that is that in other countries, there is already some pre-selection for students who come to the university; whereas, we don't have that kind of pre-selection here; anybody from the high school who comes can come into the university and take physics courses here; and so they don't have to be prepared for physics, in that sense.(1)
*Probably; I think that the ones who actually get admitted have been reasonably prepared; I don't know all about the students who don't get admitted; we don't actually have many students from Mississippi; I don't know if that's because they are not well-prepared or if it is because the well-prepared ones choose to go somewhere else.(1)
*They are not quite as well-prepared, but they can do well.(1)
*We get students from Mississippi, other states, and abroad; and I have had strong students from Mississippi, just as from other states; I think, in general, that the students are qualified to go to graduate school, and they make it into graduate school; they can be as strong as students from other places; so, I can't say that they are significantly weaker than students from other places; one can maybe argue that in some more detail, but it might be a hard thing to gauge due to the fact that there are not that many students going through the physics system.(1)

*It is hard for me to tell because I have not taught the undergraduates in Mississippi; but, I judge that more by who we are admitting; and either they are not coming here or they are not as well-prepared, one of the two.(1)

*No; our own students seem to be less well-equipped to compete in the class work with the students that we get from other places, most of whom are foreign students; what we have found, in general, is that the students from some of the smaller state universities, regionally, have not been as competitive with the foreign students.(1)

*I don't think they are; in terms of graduate students, the students who come from Mississippi universities aren't as prepared; and, I think that tends to be the reason we end up outsourcing—getting students from outside the country and even students from different states.(1)

*This is a hard question; for sure, at Ole Miss, I definitely notice that there is a really a wide range; some students from Mississippi are going to be quite well prepared and do extremely well, but overall, I think there is definitely a lack of preparation; and most of it is foundational knowledge such as math; or their critical thinking skills might not be as good; and this is not even about physics; and although I am not certain, I generally suspect that these deficiencies occur primarily because the high school teachers who teach the students have the same problems; so, in that sense, it is not even the fault of the students; but, yes, in general, I would say that their preparation is not as good.(1)

*We have students from other places who appear to be better prepared than the Mississippi students; we have had some very good undergraduates coming from Mississippi, but for graduate students, I think the standard has been not as good as we would like it to be.(1)

*This is a difficult question; I think that it depends on a case-by-case basis; but, overall, if I have to average over all the graduate students that I had dealt with in the past few years, I would say that they are not; if comparing them with students from other regions of the U.S. or with students from other countries, I would say that, overall, the Mississippi students are not as well-prepared for graduate classes when they first start.(1)

*We do not get very many Mississippi native students in the graduate program; we have maybe one or two in the program right now, and one is struggling a little bit; but that is just one data point; so, I do not think we really have enough data to know if Mississippi students, in general, are prepared for graduate studies; I do know that we have placed several undergraduate students, coming out of our department, into other graduate programs, and they are doing well; so, I feel like we are preparing our undergraduate students, the top-tier ones, perfectly well for graduate studies at other places.(1)

*I have not talked to students from those other places, but just based on anecdotal information, my understanding is that they're not quite as well-prepared for graduate level; but, I do not have much experience to base that on.(1)

Overall, seven of the twelve professors who were interviewed indicated that Mississippi students were not as well-prepared for graduate-level physics as students from other places. Three of the twelve professors who were interviewed indicated that the Mississippi students were as well-prepared for graduate-level physics as students from other places. There were also statements which mentioned that the professors were unsure and that it was hard to gauge (i.e. measure). Also, two professors mentioned that we [at the University of Mississippi] do not have many Mississippi students in the graduate program for physics. Also, five professors (or research physicists) indicated that there are some Mississippi students who seem to be reasonably well-prepared, and who do well.

Some of the items which were mentioned by some of the professors [and which will likely be problems for Mississippi students] are a lack of preparedness, and competition with students from other countries. One professor mentioned that the students who come from other countries have already gone through a "pre-selection" process which Mississippi students do not have to go through. Another professor referenced a lack of preparation and foundational knowledge (such as in math). The professor mentioned that he suspected that the students had high school teachers who had similar problems. The full interview transcripts show the complete questions and answers in their full context.

Research question #12.

What are the opinions of physics professors at the University of Mississippi concerning how Mississippians can improve physics education in the state?

There was a question (#12) on the professors' survey form (see *Mississippi Physics Education: Instructor Survey Form* in Appendix C) which asked the professors to give their opinion of this question. The summary table below shows the material that was gathered by analyzing the written answers of the professors for Question #12. These answers (in the table which follows) were provided by physics professors and research physicists from a sample pool which involved three state universities in Mississippi (the University of Mississippi, Mississippi State University, and the University of Southern Mississippi). Thus, technically, some responses of professors from other state universities than the University of Mississippi are also included in the discussion below. The researcher analyzed the written responses of the professors and put them into broad "thematic categories." The parenthesis next to each statement (or theme) represents the number of professors whose answer contained something that fit into that particular theme. To see the original wording of the professors' answers, review their written responses to Question # 12 (on the instructor survey form). The responses were typed up and are included in this research project.

Table 401

What Can Be Done to Improve Physics Education in Mississippi? Common Themes from the Written Responses of the Physics Instructors ($N_{Instructors\ Surveyed}$ = 16) to Question #12 on the Instructor Survey Form

In your opinion, what can be done to improve physics education in Mississippi so that students are better prepared for the rigors of physics?
* Improve math education; better math preparation. (7)
* Recruit qualified physics teachers in MS high schools; better physics preparation in high school. (5)
* Improve education/science education of young children, and of children in elementary or middle school (i.e. start from a young age). (4)
* Teach problem solving; improve critical thinking skills. (3)
* Allow more creativity, open-ended projects. (2)
* Improve education in high school. (1)
* Change perception of how science is seen in the state. (1)
* Greater communication between Ole Miss and Mississippi State and high school physics classes. (1)
* Improve math and physics courses in college. (1)
* Overhaul (i.e. completely redesign) entire educational system in the state, starting from K-12. (1)
* Insist that students meet high academic standards. (1)
* Improve financial support for teachers. (1)

Note. For this table, the researcher (P. Rogers) listed the number of physicists (physics professors or research physicists) who listed each respective point (or theme category) in their written answers. It was possible for a physicist's answer to match more than one thematic category—in which case the researcher (P. Rogers) put a mark by each thematic category that matched with the physicist's answer.

Observing Table 401, one notices that the most commonly referenced theme, among all the professors' written responses, was that the students need to be better prepared in math. The second most commonly referenced theme by the professors was the idea that high schools need qualified physics teachers so that students can get better physics preparation. This was mentioned over and over again in the course of this research project. Other professors mentioned the importance of developing a science interest in children at a young age. Professors also mentioned that students needed to be taught problem-solving skills; critical thinking. Another two professors referenced the need for allowing more creativity and open-ended projects. A very common item that was mentioned throughout the course of the research project (and which is listed once in the table above) was the need to pay teachers enough so that well-qualified teachers would want to come teach. There were a variety of answers to the question of what to do to improve education in Mississippi. One researcher stated that the whole educational system needs to be overhauled. It was mentioned that the perception of science needed to be changed in the state. It is important to mention that the sample of physics professors who were given the written survey (from which the above responses were obtained) consisted mostly of physicists who work or once worked at the University of Mississippi, but it also included a very small number of professors (three or less) who work or once worked at another state university in Mississippi.

Another part of the research project which dealt with this question was Interview Question #4 of the interview form with the 12 physicists from the University of Mississippi [see *Qualitative Survey Form (Interview with Physics Instructors)* in Appendix C]. The researcher transcribed these interviews. Then, the researcher tried to categorize the main answers from the interviews into themes or categories. The summary results of that portion of the research (dealing with Question #4) are shown in Table 402 below:

Table 402

What Can Be Done to make the Mississippi Education System Better? Commonly Mentioned Themes from the Main Answers (to Interview Question #4) of the 12 Physics Professors who were Interviewed

What could be done to make the Mississippi education system better for producing highly skilled science and math students?
*Increase the number of highly qualified teachers.(8)
*Increase the number of highly qualified high school physics teachers.(7)
*Improve the level of teaching in school by the teachers who are there.(5)
*Put more focus on the cultural factors in the community and at home which cause students to more highly value science and academic pursuits.(4)
*Make sure that we pay our teachers decent salaries.(3)
*I am not extremely familiar with the Mississippi education system.(3)
*Increase the amount and quality of math courses that students take.(2)
*Increase the number of highly qualified math teachers.(1)

From the interview with the 12 University of Mississippi physics professors, the items above were the ones that were referenced as the author endeavored to break down the interview transcripts into common themes. We see again that high on the list is to increase the number of highly qualified teachers—some referenced it more generally, and some specifically referenced high-quality physics teachers in high school. Improvements in the quality of teaching represented the top three most referenced items. Also very high on the list was the need to put more focus on the cultural factors in the community and home which cause students to more highly value science and academic pursuits. The importance of good pay for the teacher was referenced several times. And, the ever-present theme of better math education was present among the answers of the professors.

Another portion of this research project which dealt with the question of what could be done to improve the Mississippi education system was Question #6 from the interview form with the five Mississippi-native physicists [see *Qualitative Survey Form (Interview with Successful Mississippi Physicists)* in Appendix C]. The researcher endeavored to place the interview answers into themes or categories. The results of that portion of the research which deals with Question #6 are shown in Table 403 which follows:

Table 403

What Can Be Done to make the Mississippi Education System Better? Commonly Mentioned Themes from the Main Answers of the 5 Mississippi-Native Physics Professors who were Interviewed (Interview Question #6)

What could be done to make the Mississippi education system better for producing physics students who will be in a position to have a successful career in physics?
*Students need better math preparation in the high schools. (3)
*Although I have some ideas about it, I do not fully know the answer; I do not fully know how to do it. (3)
*The math education departments need to have higher standards so that mathematicians who understand the subject can be produced rather than people who use fad methods. (1)
*Having advanced math classes in high school would help. (1)
*Better science preparation in the high schools would be beneficial. (1)
*We must also engage young students before they get into high school so that they do more than just memorize facts and figures; we must do less of teaching students to take a test and teaching them to memorize things, and we must do more of bringing in activities that they can be a part of. (1)
*It's not really a technology answer, such as giving the entire classroom laptops, but it is more about having solid teachers who can inspire kids to want to do these things. (1)
*We have to invest in our high school math and physics teachers. (1)
*We have to be sure that we financially reward our elementary and high school teachers adequately. (1)
*It would be beneficial to have some economic incentives, such as scholarships or fellowships for students. (1)
*It would be beneficial to have jobs that the students can get once they get the degree. (1)
*I think we do a pretty good job, especially at certain schools and locations in the state, such as near some of the major universities; so there are opportunities for students; I think good students are hard to hold back; if they know what they want to do, and you give them a way to get there, they get there. (1)

One of the professors in the group of "native-born" Mississippi professors was actually born in another state, but moved to Mississippi as an infant. The researcher decided to classify this professor with the other four native-born Mississippians. Also, since the sample of Mississippi-natives was very small, the researcher included all of their referenced themes, not just the ones that were referenced more than once. Plus, these professors served as part of the core purpose of the research to better understand physics education in Mississippi. Two of these professors work or once worked at the University of Mississippi; two of the professors work or once worked at Mississippi State University; and one of the professors works or once worked at the University of Southern Mississippi.

At the top of the list of most-referenced themes (for how to improve Mississippi physics education) was the need to facilitate better math preparation for high school students. One professor mentioned that the math education departments did not need to concentrate on fad methods, but needed to have higher standards so that they could produce mathematicians who understood the subject. Another theme which was referenced was the need to have advanced math classes in high school. It was also mentioned that we need to invest in our high school math and physics teachers.

Interestingly, it seemed that one theme which was referenced by three of the five professors was a feeling that they did not really know what to do to fix the problem. The theme of improving the quality of high school education was also mentioned by the Mississippi-native professors. One professor stated that it is not a technology answer. The theme of needing to financially reward teachers properly was mentioned—and in this case, it was mentioned that both elementary and high school teachers need to be rewarded adequately. Another idea which was mentioned was the importance of bringing in activities that students can participate in. Also, one professor mentioned that it would be good to have more fellowships and scholarships (economic incentives) for students.

In summary, the physics professors who participated in the survey or in the interviews very commonly emphasized the need to improve physics education in the high schools, the need to make sure that we have quality physics teachers in high schools, and the need to improve the math education of the students. It was also common for some to mention the need to reward teachers financially so that we can attract quality high school teachers. Cultural factors, such as improving the way science is seen in the state and such as installing high academic standards (in the schools and in the home), were also referenced. Many other specific factors were mentioned, but these are some of the factors which most commonly referenced by the group of physicists who participated in the surveys and interviews. The full interview transcripts and the full transcripts of the written responses to the surveys are included in the Appendix. These can show the more complete context of both the questions and the answers.

Research question #13.

What are the opinions of successful native Mississippi physicists concerning difficulties faced by Mississippians in physics and how these difficulties can be overcome?

Three questions (#2, 3 and 5) from the interview with the Mississippi-native physicists address many aspects of this research question. The questions can be referenced on the *Qualitative Survey Form (Interview with Successful Mississippi Physicists)*. The full interview transcripts with the native Mississippian professors can be referenced (see Appendix E) in order to see the full context of how the questions were asked and answered. However, the researcher analyzed the interview transcripts in order to place the answers into common themes or categories, if possible.

The table below (see Table 404) shows the main categories which the Mississippi-native physicists mentioned concerning the obstacles which they had to overcome as a student and during their years as a physicist:

Table 404

Obstacles the Successful Mississippi Physicists had to Overcome; Most Commonly Mentioned Themes from the Main Answers of the 5 Mississippi-Native Physics Professors who were Interviewed (Interview Question # 2)

What obstacles did you have to overcome during your years as a student and during your years as a physicist?
*I had a discouraging experience with a certain professor's class. (1)
*I was the first person in the family to attend college. (1)
*I had to quit work so the studies could be properly attended to. (1)
*The financial burden of attending college upon my family was an obstacle. (1)
*The financial burden experienced during the time of being a graduate student was an obstacle. (1)
*The decision of where to go to graduate school was an obstacle. (1)
*When I initially entered graduate school, I had somewhat of a lack of confidence about my ability to do the academic work; this was due to the fact that I somewhat believed some of the negative things you hear in the media about Mississippi academics. (1)
*I had to fix or repair a faulty piece of electronics equipment which was necessary for certain measurements. (1)
*I do not think I had any obstacles. (1)

Note. Five native Mississippi professors were interviewed for the above table. Four of them were born in the state of Mississippi. The other one moved to Mississippi as an infant. They were all classified as Mississippi-Native physicists for the purposes of this research project.

One can see from the list in the previous table that there were a variety of different obstacles that the Mississippi native (physicists) had to overcome. Among these obstacles were financial burdens, lack of confidence (academically speaking), and a discouraging class experience. Also mentioned was the need to quit work so that more emphasis could be devoted to academic studies. Similar obstacles, in the opinion of the researcher, are likely to be experienced by Mississippi students today—and indeed, by students from other states or countries. It is noteworthy that one professor mentioned that there really were not any obstacles. The full interview transcripts (see Appendix E) show these discussions with much more depth.

Question #3 could also provide information which would be useful to help understand what difficulties Mississippians in physics might experience. This particular interview question deals more with the difficulties that Mississippi's students face when it comes to the academic rigors of physics and whether or not Mississippi students are as well-prepared academically as other students. The interview transcripts of the professors were analyzed for common themes, and the summary results are shown in Table 405 which follows:

Table 405

Are Mississippi Students well-prepared for the academic rigors of physics? Most Commonly Mentioned Themes from Main Answers of the 5 Mississippi-Native Professors who were Interviewed (Interview Question #3)

Do you think that Mississippi students are as well-prepared, as other students, for the academic rigors of physics?
It varies greatly from school to school; there are some great schools and some very poor schools. (3)
*We probably have more weak schools than most states. (1)
*I think it depends almost entirely on where the student went to high school and the physics teacher who was there; I just cannot overstate the value of a good high school experience in preparing kids for a career like physics. (1)
*I suspect that it is the way that it has always been in that there are very few physics teachers which means that there are few students who take physics in high schools; and it is hard to get students interested in physics unless they can get in and start doing it; you cannot just talk to them about physics, you have to let them do all the things you do; and physicists understand that, but they just do not have the equipment, money, time, or teachers to do that sort of thing.(1)
*It's something it would be nice to see the state improve. (1)
*I do not think they are as well-prepared as they should be. (1)
*I do not have enough experience with teaching students from other places in order to say for certain whether or not Mississippi students are as well-prepared as the average student from other places around the country. (1)
*I do not know that I am in the position to gauge about Mississippi students in general, now; I have been away from that arena for a long time; however, I do know that one local school has a good physics program for the good students, but I have somewhat of a reserved opinion about what schools in Mississippi, in general, do for the average person that comes through school. (1)

The Mississippi-native professors who were interviewed seemed to place a great emphasis on the fact that there are a variety of different high schools, and that the quality of the high school education is very important in determining how well a student will be prepared for the academic rigors of physics. One professor mentioned that Mississippi probably has more weak schools than most states. Another professor suspected that there probably are not enough physics teachers in the high schools, which makes it hard to prepare physicists. These are some of the issues that might face Mississippi students in the field of physics, according to the answers given by the native Mississippi physicists in answer to Interview Question #3 of *Qualitative Survey Form (Interview with Successful Mississippi Physicists)* which is included in Appendix C.

Another question (#5) from the interview with successful Mississippi physicists addresses the issue of how the Mississippi physicists were able to be successful in physics. In a sense, this can be used to understand how they overcame various obstacles that might have faced them. The interview transcripts of the professors were analyzed, and the answers were categorized into themes. The results of that portion of the research are shown in the summary table (Table 406) which follows:

Table 406

Key Factors in the Success of the Successful Mississippi Physicists; Most Commonly Mentioned Themes from the Main Answers of the 5 Mississippi-Native Physics Professors who were Interviewed (Interview Question #5)

What were the key factors, in your opinion, to your success in physics?
*I had a good teacher or good teachers along the way. (3)
*I worked hard. (2)
*My high school math teacher taught advanced math class and covered much of the college curriculum; and that helped me develop a good math background for my college math classes. (1)
*I was fortunate enough to encounter the right people at the right time, such as good math and physics teachers in high school and college; everywhere along the way, I had other people who helped me be successful. (1)
*I had some good mentors. (1)
*While I was an undergraduate and graduate student, I had the time to really study and learn physics and not just try to get a grade in the class. (1)
*I had the personal drive to get a PhD, and did the things necessary to become a physics professor. (1)
*I grew up on a farm doing very hard physical labor, and I did not want to keep doing that; thus, I was highly motivated to go to college so I could get a job that required an education. (1)
*Being able to have an assistantship helped out. (1)
*I had several friends who got married and had to drop out; some had marital problems; if you get married and you do not have any money, you are liable to have all kind of financial troubles; so, for that reason, I just told myself I was going to wait; I did not want to be side-tracked. (1)
*I was able to be versatile; I have worked in a wide variety of different fields. (1)
*I am not the typical physicist, I am a holistic thinker; I ask many questions. (1)
*I would not necessarily consider myself to have been a successful physicist, but I was successful as a physics teacher. (1)

The most commonly mentioned theme was the fact that the Mississippi physicists had teachers and mentors who really helped them along the way. The theme of "hard work" was mentioned more than once. One professor mentioned that the ability to be versatile was important. Interestingly, one professor mentioned that the choice to wait about getting married was important, because some of his classmates who had gotten married while in school encountered difficulties. Another professor mentioned that having an assistantship helped. One professor mentioned that he had the drive in order to obtain a PhD. It was important to one professor that he had time to really study and learn physics as an undergraduate (and as a graduate) student, and not just worry about getting a grade for a class. All of these reasons (and more) were mentioned by the professors. One professor even mentioned that he did not really feel like a successful physicist, but that he felt that he was a successful physics teacher.

In summary, the interviews with the Successful Mississippi Physicists revealed that as students, they faced many obstacles such as financial burdens, the need to quit work, lack of academic confidence, and a bad experience with a certain class. Mississippi students today also may face academic burdens associated with being in a state which, according to one professor, probably has more weak schools than most states. One professor felt that Mississippi students were not as well-prepared as they should be. Another mentioned the shortage of physics teachers as being a problem.

On the positive side, the professors mentioned great teachers and mentors as being a major reason for their success as physicists. This was the most commonly mentioned theme for their success. The next most common theme mentioned by the successful Mississippi physicists was "hard work." The ability to be versatile was mentioned as important to one professor. Being able to have an assistantship was also mentioned as a positive element in one physicist's success. Another successful Mississippi physicist felt that it was important that he had the chance to really learn physics rather than to just study it in order to get a grade.

All of these issues, along with other issues, were discussed by the successful Mississippi physicists in their interviews with the researcher. The researcher travelled to three state universities in Mississippi to collect these interviews. The three universities were the University of Mississippi (in Oxford, MS), Mississippi State University (in Starkville, MS), and the University of Southern Mississippi (in Hattiesburg, MS). The researcher learned a great deal in the interview process with these successful Mississippi physicists, and he hopes that their stories will provide information, encouragement, and inspiration for other Mississippians who would like to pursue careers in the field of physics. The researcher hopes also that the information from the interviews will provide historical documentation concerning physics in Mississippi during the latter half of the 20th century and into the 21st century.

Some Other General Observations

This research project required a large amount of data to be collected and analyzed. The complete analysis of the entire body of data which was obtained would fall outside the scope of this research project. From the survey data alone, which is included in this dissertation, one could find descriptive data on many interesting questions in physics—other than the ones which have already been discussed. For example, one could compare the physics attitudes of the Engineering Physics II students versus the Pre-med Physics II students. One could put more emphasis on understanding the different physics views of different ethnic groups--although the sample sizes are small in many cases. One could also spend more time comparing the physics views of A-level, B-level, and C-level students, and then one could compare these with the professors' views.

For example, if one wished to descriptively compare the views of A-level, B-level, and C-level (or below) students on the topic if "physics intelligence", such as was referenced by Questions #11 and #12 of the student survey form, one could use the results of the survey data to develop comparison tables such as the following two tables.

Table 407

Answers Given by the "A," "B," "C or Below" Physics Students, and the Physics Professors to Question #11[a] of the Student Survey Form, "Choose which factor is more important in order for someone to become a good physicist?"

Answer	A-level College Students (N_{AL} = 60)	B-level College Students (N_{BL} = 39)	C-level or Below College Students (N_{CL} = 14)	Physics Instructors (N_{PI} = 16)
A person must be born with greater natural mental abilities for physics.	10.0 %	7.7 %	7.1 %	25.0 %
A person must spend many hours in personal study of physics.	38.3 %	48.7 %	71.4 %	18.8 %
They are of the same importance	51.7 %	43.6 %	21.4 %	50.0 %
No Answer was Chosen	NA	NA	NA	6.3 %

[a]This question (Question #11 on the student survey form) corresponds with Question #4 on the professor's survey form (see *Mississippi Physics Education: Instructor Survey Form*, in Appendix C).

Table 408

Answers Given by the "A," "B," "C or Below" Physics Students, and the Physics Professors to Question #12[a] *of the Student Survey Form, "Which statement best represents your opinion?"*

Answer	A-level College Students ($N_{AL} = 60$)	B-level College Students ($N_{BL} = 39$)	C-level or Below College Students ($N_{CL} = 14$)	Physics Instructors ($N_{PI} = 16$)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	41.7 %	43.6 %	35.7 %	25.0 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	55.0 %	56.4 %	64.3 %	56.3 %
No Answer was Chosen	3.3 %	NA	NA	12.5 %
Other	NA	NA	NA	6.3 %

[a]This question (Question #12 on the student survey form) corresponds with Question #5 on the professor's survey form (see *Mississippi Physics Education: Instructor Survey Form*, in Appendix C). The only difference was the slight difference in boldface in the answer choices.

One of the items, in terms of descriptive statistics, which stands out from Table 407 is that the "C-level or Below College Students" in this sample seemed to feel (more strongly than the other groups compared in Table 407) that it was the quantity of hours spent in personal study of physics rather than any natural-born mental abilities which are more important for making someone a good physicist. This would seem to imply that the "C-level or Below College Students" in this sample were more likely to discount the importance of natural born mental abilities for physics. Yet, in the next table (Table 408), the "C-level or Below College Students" in this sample answered with the highest percentage of the four groups who were compared (in Table 408) that the majority of people are not born with the necessary mental capacity to become physicists when they reach adulthood. This would imply that, at least for that question, the "C-level or Below College Students" in this sample were placing a stronger emphasis (as a group) on the necessity of having natural-born mental abilities for physics. Ultimately, the sample size of the "C-level or Below College Students" was small, thus the percentages obtained from tabulating the surveys have much more statistical uncertainty. This highlights the fact that although descriptive statistics are useful, they sometimes provide conflicting information which might not be generalizable to the larger population of students. Perhaps such conflicting cases can be studied by future researchers with larger sample sizes, and more precise measuring instruments.

A general question which interested the researcher was the comparison of how "A students," 'B students," and "C students" see themselves in terms of their math and physics abilities. The survey data can be consulted and used to provide a description (based on descriptive statistics) for this question. The following two tables show the comparison between the students who self-described their college physics performance with an "A"; those who self-described their college physics performance with a "B"; and those who self-described their college physics performance with a "C" (or lower). The comparisons which are shown are their answers to the questions of how good they are in math; and how good they are in physics.

Table 409

Survey Answers Given by the "A," "B," and "C or Below" Physics Students to Question #8 of the Student Survey Form, "How good are you at math?"

Answer	A-level College Students (N_{AL} = 60)	B-level College Students (N_{BL} = 39)	C-level or Below College Students (N_{CL} = 14)
Excellent	41.7 %	25.6 %	21.4 %
Above Average	45.0 %	66.7 %	28.6 %
Average	13.3 %	7.7 %	42.9 %
Below Average	0.0 %	0.0 %	7.1 %
Poor	0.0 %	0.0 %	0.0 %

Table 410

Survey Answers Given by the "A," "B," and "C or Below" Physics Students to Question #9 of the Student Survey Form, "How good are you at physics?"

Answer	A-level College Students (N_{AL} = 60)	B-level College Students (N_{BL} = 39)	C-level or Below College Students (N_{CL} = 14)
Excellent	13.3 %	0.0 %	7.1 %
Above Average	63.3 %	25.6 %	7.1 %
Average	20.0 %	69.2 %	57.1 %
Below Average	1.7 %	2.6 %	21.4 %
Poor	0.0%	0.0 %	7.1 %
No Answer was Chosen	NA	2.6 %	NA
Other	1.7 %	NA	NA

In Tables 409 and Table 410 above, we see the theme highlighted again that the Physics Lab II students generally felt that they were better at math than they were at physics. Also, the tables show that, in general, the A-students are "self-aware" in the sense that they do tend to believe (roughly 87% believed) that they are either excellent (41.7%) or above average (45.0%) in math. For the B-level college students in this sample, roughly 92 % believed that they were either excellent (25.6 %) or above average (66.7 %) in math. The C-level (or below) college students in this sample rated themselves lowest of the three groups being compared, when it comes to the proportion that described themselves as either excellent or above average in math. Approximately 50 % of the C-level (or below) college students indicated that they were either excellent

(21.4 %) or above average (28.6 %) in math. The other 50% of C-level (or below) college students described themselves as “average” or “below average” in math.

When it comes to their views of their ability in physics, the percentages (who rated themselves high) were even lower—for “A-level College Students,” “B-level College Students,” or “C-level or Below College Students.” Yet, in general, the percentages did seem to portray a picture of “self-awareness” about their own abilities. In other words, the A-students rated themselves the highest, and the C-level (or below) students rated themselves the lowest, overall. For example, roughly 77% of the A-level college students rated themselves as either excellent (13.3 %) or above average(63.3 %) in physics. For the B-level college students, 25.6 % rated themselves as either excellent (0.0 %) or above average (25.6 %) in physics. For the C-level (or below) college students, only approximately 14 % of the students rated themselves as either excellent (7.1 %) or above average (7.1 %) in physics. Thus, in summary, the A-level, B-level, and C-level (or below) students tend to rate themselves in the “appropriate order” for their grade in the physics class. And, overall, they all rate themselves to be better in math than in physics.

Many interesting questions would likely arise if one examines the descriptive statistics of the large amount of survey data, piece by piece. In this dissertation, the researcher has only highlighted some of the major summary results which addressed the research questions or which otherwise attracted the attention of the researcher (or addressed aspects important for this dissertation). A large amount of tabulations were done to obtain the descriptive statistics of the various sample groups. These are included in the Appendix, and the researcher hopes that they will provide much interesting and useful information for future researchers or for those who have a deep interest in improving physics education in Mississippi and in all states or countries.

What was Learned from the Written Responses of the 16 Physics Professors to the Short-Answer Survey Questions?

The researcher included the written responses of the students and the professors within this dissertation. Also, the researcher endeavored to classify the various answers of the students and professors into themes. The full theme tables which summarize the professor's written responses (to Questions #10-12 of the Instructor Survey Form) can be found in Table 46, Table 47, and Table 48.

It was found that the great majority (81.3 %) of physics professors who were surveyed chose to pursue a career in physics due to an interest in, a love of, or a passion for the subject. It was found that the physics professors would recommend a career in physics to students who were in the process of choosing a major. For some professors (43.8 %), this was almost an unqualified “yes.” Other professors (56.3 %), indicated that their “yes” for a recommendation (to students) for a career in physics was a very “qualified yes.” In other words, they would only recommend a career in physics if the student had the talent, background, and work ethic.

In their responses to Question #12 on the survey form, which asks about what can be done to improve physics education in Mississippi so that students are better prepared for physics, the 16 professors who completed the surveys were of the opinion that we in Mississippi must improve math education (to foster better math preparation) (43.8%), we must recruit qualified physics teachers for Mississippi high schools (so as to foster better physics preparation in high school) (31.3 %), and we must improve the education/science education of young children, starting from elementary or middle school (so as to start improving education at a young age) (25.0 %). These were the top three themes mentioned by the physics professors in their written responses survey question # 12 (on the Instructor Survey Form) for how to improve physics education in Mississippi. There were many other items mentioned concerning how we might improve physics education, other than these top three. The complete context of the professors' answers can be fully reviewed by reading the full responses of the professors. Also, a full theme table (see Table 48) for the professors' written responses to survey Question #12 (dealing with how to improve physics education in Mississippi) is included just below the written responses of the professors.

What was Learned from the Written Responses of the 113 Physics Students to the Short-Answer Survey Questions?

As was the case for the physics professors, the full written responses of the students who were surveyed are included in this dissertation. A total of 113 students turned in completed (or mostly completed) survey forms. The researcher typed all of these responses up, and included them after the tables for the student survey results. The written responses of the students were for Questions #17-20 on the Student Survey Form. The researcher endeavored to develop theme tables to categorize the written responses which the students gave for these questions. The theme tables (see Tables 362-368) for the students' written responses can be found directly after the students' typed written responses (see Appendix D).

From Table 362, we see that roughly half of the Physics Lab II students enjoy the subject of physics; roughly a quarter do not enjoy physics; and roughly another quarter of the students "somewhat" enjoy physics. From Table 363, one can find many of the reasons (separated by themes) for some of the aspects of physics that students enjoy. The largest portion of the positive aspects which were listed fell into the broad theme of the "*understanding and concepts*" aspect of physics. For example, 15.2 % of the 105 positive aspects listed fell into the theme of "*It helps me understand nature and the world around me; it helps me understand many everyday things I experience.*" Some other commonly mentioned themes relating to positive aspects of physics were "*I enjoy math*" (8.6 % of the positive aspects listed); "*Physics is interesting*" (8.6 % of the positive aspects listed); and "*Physics is applicable to life*" (7.6 % of the positive aspects listed). Also, mentioned was "*I enjoy solving problems; physics improves my problem-solving ability*" (7.6 % of the aspects listed).   Students also mentioned that, "*It helps me understand how things work*" (7.6 % of the positive aspects listed). Another commonly mentioned item was, "*I enjoy the concepts; I enjoy understanding the concepts*" (7.6 % of the positive aspects listed). These last two themes also fell into the "*understanding and concepts*" broader theme. The full theme table (Table 363) shows many of the other positive aspects of physics that students listed, and it also shows how these were categorized into various themes.

Of course, many students also listed negative aspects about physics--aspects about physics that they do not enjoy. Table 364 is a theme table which shows the major categories that these negative answers fell into. There were 45 negative aspects about physics which were listed in the students' responses. The largest theme (percentage-wise) for negative aspects was "*Physics is difficult for me to understand; I do not enjoy it because it is very difficult.*" A total of 17.8 % of the negative aspects which were listed fell into that category. This fell into the broader theme of "*Physics is difficult to understand*." Several other negative answers fell into this category, and the "*Physics is difficult to understand*" category was the category that contained the largest portion of the negative aspects which were listed. Another theme which was relatively common, among the negative answers, was "*I don't like math; the math is too complicated*" (11.1% of the negative aspects listed fell into this category). Some students' negative answers fell into the theme of, "*Physics does not interest me*" (6.7 % of the negative aspects which were listed). Others listed aspects which fell into the theme of, "*It does not apply to my major; it does not apply to my future job*" (6.7 % of the negative aspects which were listed). The full theme table (Table 364) shows many other of the negative aspects which were listed, and it shows how they were classified into broader themes, as well.

Table 365 is a theme table which shows the main reasons listed by the students as to why they chose not to major in physics. The researcher analyzed the students' written responses to Question #18 in order to develop this particular theme table. There were 124 reasons listed among the answers of the 113 students. The largest portion of the reasons given by the students fell into the theme of "*I am more interested in another subject, major, or profession*" (35.5 %). Another very common theme among the answers which were listed was "*I dislike physics or don't enjoy it*" (12.1 %). Also high on the list of reasons why the students chose not to major in physics were, "*I am not interested in physics*" (11.3 %); "*Physics is difficult*" (6.5 %); "*Career/job prospects are better in another field*" (5.7 %); and "*I chose a major that would be better for preparing me for a career in medicine*" (4.0 %). The full theme table (Table 365) shows many other reasons for why students chose not to major in physics, and it shows how these reasons fit into broader themes.

There were four students (of the 113 Physics II lab students) who indicated that they did choose to major in physics. Question #19 of the student survey form asked the students (who majored in physics) to explain why they majored in physics. Table 366 summarizes the students' responses to why they majored in physics. There were nine different reasons listed among the students. In terms of percentages, the reasons that were listed by the most students (actually two, in each of these cases) were, "*I enjoy problem solving*" (22.2 % of the 9 reasons listed); "*A degree in physics can lead to a wide variety of careers*" (22.2 % of the 9 reasons listed); and "*It will be beneficial for me in my pursuit of a career in medicine*" (22.2 % of the 9 reasons listed).

Table 367 was an analysis of the students' written responses concerning whether or not they have chosen a major, which was the first part of Question #20 on the student survey form. It appears that for this sample of 113 physics lab students, nearly all of them had chosen a major at the time of the survey. A total of 93.8 % indicated positively that they had chosen a major, and the other students who did not positively answer (in a way that could be described as "yes") had listed a major on the demographic information section of the survey or had otherwise indicated in a previous part of the survey that they had chosen a major. No students answered positively "no" that they had not chosen a major. Thus, it appears clear that at least for this sample of students, the great majority—probably all of them—had chosen a major.

The second part of Question #20 on the student survey form asked them why they chose their particular major. A theme table (Table 368) was developed from the written responses of the students to that question. A more condensed summary table, of the main answers from that table, is shown below.

Table 411

Summary Table Showing the Top Eight Themes for the Reasons Students Chose Their Particular Major; Compiled from the Theme Table for Question #20 on the Student Survey Form

Broad Themes (The Number of Physics Students who Listed a Reason Categorized by the Broad Theme is Shown in Parentheses)
***** Interest or enjoyment of the subject, major, or career. (41)
* Practicality and applications, such as for building things, creating things, and working on things. (21)
*Interest in the medical field, the human body, medicines, and health professions. (19)
*I enjoy math or science. (15)
* There are many job opportunities associated with this major. (12)
* I want to prepare for entry into medical school and a career as a doctor. (11)
* I am good at it; it fit my skill set. (8)
* It offers a way to combine my various personal interests and certain career attributes associated with this major. (8)

It is important to remember that the students who were being surveyed were in Physics II labs which were geared either toward “engineering students” or toward “pre-med students.” Thus, it would be logical that interests which are important to these students would show up very prominently on the list. Yet, these are the type of students who most often take physics classes. And thus, such information about the reason these students chose their particular majors, may be interesting to physics departments. It appears to the researcher that the medical fields and medical professions play a very prominent role in steering the students into certain majors. In other words, they often choose majors that will help them either get into the medical fields or succeed in the medical fields. According to the data from the themes table, interest or enjoyment of the subject, major, or career is the most commonly listed reason the students gave for choosing their major.

What was Learned from the Interviews of the 10 Physics Students?

The interview with the 10 Physics Lab II students was summarized by a theme table (Table 369) which was included just below the "Main Answers" from the student interviews. By reviewing Table 369, we are able to see a main summary of the answers the 10 students gave in the interviews.

In answer to Interview Question #1, concerning whether or not the students think physics is an important subject, the students mentioned that they do think that physics is an important subject. They mentioned that it helps us understand nature and how things work. They also mentioned the importance of physics to engineering applications. It was also mentioned that physics is a great subject to have a good background in, and that it is important since so many subjects stem from it.

In their answers to Interview Question #2, it was found that none of the ten students (who were interviewed) majored in physics although one plans to get a master's and maybe a PhD in physics at a later time. Among the reasons the students (who were interviewed) gave for not majoring in physics was that they were attracted to the practical applications associated with an engineering major; that they were more interested in another subject; that they were interested in applications more than in theories; and that they felt that another major was better designed to help them get into medical school.

Although the majority of the students who were interviewed indicated that they felt well-prepared for physics (see Interview Question #3 on Table 369), some of them indicated that they felt more prepared for Physics I than for Physics II. Generally speaking, Physics I covers topics such as measurement, dimensions, motion, vectors, Newton's Laws of Motion, gravity, momentum, and many other aspects associated with the field of mechanics. Physics II, however, often covers arguably more abstract topics associated with electricity, magnetism, and optics. (At least, this is how physics classes are arranged at the University of Mississippi and at many community colleges, as far as the researcher is aware). It appears that a noticeable portion of the students who were interviewed felt more unprepared for Physics II than for Physics I. The topics of electricity and magnetism are probably considered more abstract, and some relatively high-level math is required—especially for the calculus-based physics course (i.e. engineering physics). In general, integral calculus is used quite extensively in the description of Maxwell's Equations. In the Pre-med physics classes, integral calculus is not used. However, rather cumbersome math equations are used to describe complicated electrical and magnetic phenomenon. Also, the correct methods of solving problems relating to Kirchhoff's laws can be confusing and difficult to learn at first, for students in Engineering Physics or Pre-med Physics. And, the subject of optics can be rather abstract and confusing, at times, also. Although the researcher cannot be certain, perhaps these are some of the reasons why some of the students might feel more unprepared for Physics

II. It is also important to note that several students referenced the fact that they did get a good high school physics preparation.

As far as what can be done to help students have a better experience studying physics (see Interview Question #4 in Table 369), one of the main themes some of the students mentioned is that at the college level, there is not enough focus on the concepts behind the math. Personally, the researcher has found books on "conceptual physics" to be very helpful in this regard. Indeed, it seems that ideally, it would be good for students to take such a "conceptual physics" class (with very little math) before ever taking the more stringent introductory to college physics course.

What was Learned from the Interviews of the 12 University of Mississippi Physics Professors?

In Table 370, the researcher organized the twelve University of Mississippi professors' interview answers into themes or categories. The full theme table can be seen in Table 370, and the full contexts of the questions and answers (from the interviews) can be seen by reviewing the interview transcripts. However, a very brief summary of those results will be discussed again here.

Seven of the twelve professors (who were interviewed) indicated that they did not feel that Mississippi students are as well-prepared for graduate-level physics courses as students from other places. Three of the twelve professors indicated that they feel that Mississippi students are as well-prepared for graduate-level physics courses as students from other places. Several professors referenced the point that there are some Mississippi graduate students who seem to be reasonably well-prepared and who do well. Many professors also mentioned that the question of whether or not Mississippi graduate students are as well-prepared as students from other places is a difficult question to answer (or gauge).

When asked how American students compare with international students (see Physics Instructor Interview Question #2 in Table 370), it seems that the professors leaned toward the answer that international students are generally better and more prepared. However, the results of the interviews were very wide-ranging on this topic, and many professors also said that the international students were not necessarily better students than the American students. It was mentioned by a couple of professors that international students are generally better at theoretical work whereas the American students are better in the labs. A couple of the professors referenced the point that although the international students who come here generally perform better, some American students have done very well. The full theme table (Table 370) shows other themes that were mentioned, as well as the number of professors whose answers fit into each theme.

Among the reasons for the possible differences that were mentioned by professors (on the topic of comparing international students and American students) was that the international students who come here are some of the better students, because they have already gone through a selection process. Others mentioned that international students probably get a more rigorous training in the math and physics before they come here, and this helps them with their physics performance.

Interview Question #3 dealt with the topic of economic factors, and how that might or might not affect the choices students make about choosing to pursue graduate studies in physics. Overall, many items were mentioned concerning economic factors, and these are shown in the full theme table (see Table 370). Several physics professors did think that economic factors play a large part in students choosing to pursue (or not to pursue) graduate studies in physics. Three professors indicated that economic factors are a secondary factor in the choice to do graduate studies in physics. Five professors mentioned that physics is not particularly attractive, in terms of job salaries; but two professors mentioned that the physics salaries, though not large, are decent. One point that some professors made was that at the University of Mississippi, physics graduate students receive an unusually high level of financial support which should help to ease their financial burdens as they work their way through graduate school. Some professors mentioned that students who come from economically disadvantaged areas might be more likely to have weak academic backgrounds. And, other professors mentioned that the primary reason students choose physics is because they like it and they have a passion for the subject. So, this would primarily not be an economic reason.

In their answers to Interview Question #4, the physics professors discussed several ideas for how to make the Mississippi education system better for producing highly skilled science and math students. The full list of themes referenced by the 12 professors can be seen in the theme table (see Table 370). Among the top themes which were prevalent in their answers were: increase the number of highly qualified teachers (8), increase the number of highly qualified high school physics teachers (7), improve the level of teaching in school by the teachers who are there (5), and put more focus on the cultural factors in the community and at home which cause students to more highly value science and academic pursuits (4). Also, among other things, the need to pay our teachers adequate salaries (3) was mentioned, as well as the need to increase the amount and quality of math courses that students take (2).

Interview Question #5 (of the interview with 12 UM physics instructors) dealt with the question concerning the time period in their lives during which the physicists became interested in physics. The physicists who were interviewed became interested in physics at a variety of times in their lives. Many of the physics professors who were interviewed developed an interest in physics in high school. Others developed an interest in physics in college. Others became interested in science at a young age. To the researcher, it seemed that there was no clearly noticeable pattern in the answers. For two physicists, having a telescope when they were young helped them develop an interest in physics. Some professors referenced the theme of reading popular science books (or other nice books) as being important for developing their interest in physics. Also, a couple of professors referenced the fact that their parents' interest in science was an important factor in their own interest in science. Table 370 shows the list of themes in more detail.

Interview Question #6 (of the interview with 12 UM physics Instructors) asked the professors to discuss the factors that allowed them to be successful in physics. The main themes which they referenced in the interviews were listed in the full theme table (see Table 370). However, since this is a core area which was being studied by this research project, the researcher has included the list again in a brief summary table. This table (see Table 412) shows the main themes which the 12 University of Mississippi professors who were interviewed mentioned, concerning the major factors that allowed them to be successful in physics.

Table 412

Summary Table Showing Some of the Main Factors that Allowed them to be Successful in Physics, As Discussed by the 12 University of Mississippi Physics Professors who were Interviewed

Some Main Factors that Allowed the UM Physics Professors to be Successful in Physics
**One must be willing to work hard (6)
**I enjoyed the subject; I had a passion for the subject.(5)
**I had a good academic background; I had good academic training.(5)
**One must show persistence; one must persevere through the difficulties.(4)
**I was willing to spend time on the subject.(3)
**I had a strong sense of curiosity about the world or about physics.(2)
**One cannot think too much about salaries; one cannot think too much about the time versus money equivalence.(2)

One can see that "hard work" is at the top of the list, but passion for the subject is also very high. Also, having a good academic background (i.e. good academic training) seems to be very important. It was also mentioned that persistence was necessary, and that one must spend much time on the subject. The full interview transcripts can be referenced to see the full context of the answers, and to find any other answers which might not be shown on this table of main factors.

The last question (Question #7) on the interview form [see *Qualitative Survey Form (Interview with Physics Instructors)* in Appendix C] was on the issue of whether or not the physics profession represents a profession in which Mississippi students can realistically obtain a well-paying job with satisfying job conditions. The results were rather mixed. The summary table below shows the information (in a slightly rearranged form) as it was shown on the theme table (Table 370) for Interview Question #7.

Table 413

Summary Table for Most Commonly Mentioned Themes from the Main Answers of the Physics Instructors to Question #7 of the Interview with the 12 University of Mississippi Physics Instructors

Does the physics profession represent a profession in which Mississippi students can realistically obtain a well-paying job with satisfying job conditions?
**The training that you get with a physics major will help you in many other jobs or fields of study.(6)
**Studying and understanding physics will help you gain better thinking skills.(4)
**In Mississippi, there are not as many jobs in physics as there might be in many other places.(3)
**The physics profession represents a profession in which Mississippi students can realistically obtain a good, well-paying job.(3)
**Majoring in physics will give you a very good chance of getting into medical school.(2)

It is important to mention that the table above only shows the condensed version of the answers of the physicists who were interviewed—and only the answers that were listed more than once in the analysis of themes. Thus, the full interview transcripts—and the answers shown in the “Main Answers from the Interviews with 12 Physics Professors (Separated Out Question by Question)”—show much more detail about the context of the questions and the full answers that were given by the professors (see Appendix E).

In Table 413 above, one can see that many of the most commonly referenced themes by the professors were not so much related to job opportunities directly related to physics, but instead seemed to refer to other aspects of physics--aspects which might help the student professionally in indirect ways. Many physicists (6) mentioned that the training that one obtains in physics will be helpful in many other jobs or fields of study. Others (4) mentioned that understanding physics helps improve your thinking skills. Some professors (3) mentioned that there might not be as many jobs in physics in Mississippi as in other places. But, other professors (3) mentioned that the physics profession represents a profession in which Mississippi students can realistically obtain a good, well-paying job. It was also highlighted by some professors (2) that majoring in physics will give a person a good chance to get into medical school.

What was Learned from the Interviews of the 5 Successful Mississippi-Native Physicists?

The researcher endeavored to categorize the interview answers of the 5 successful Mississippi physicists into themes. The full table of themes is shown in Table 371. However, the researcher shall briefly review each of the interview questions and the main answers or themes mentioned by the 5 successful Mississippi physicists in their answers to the interview questions [see *Qualitative Survey Form (Interview with Successful Mississippi Physicists)*].

Question #1 asked the Mississippi physicists (i.e. physics professors or research physicists) why they chose to pursue a career in physics. The most commonly referenced themes concerning this question were as follows: the fact that they had a great high school physics teacher (3), and the fact that they enjoyed the subject of physics (3). It was also mentioned by one professor that he had a good high school science and math background. Another professor mentioned that someone in his family (his father) was very involved in the sciences, and so that helped him to become involved. Another professor was offered a nice fellowship. The other main themes that were listed are shown in Table 371.

Question #2 asked the professors to discuss some of the obstacles they had to overcome during their years as a student and as a physicist. Although the researcher already discussed their answers to this question in the discussion of one of the research questions, the researcher will briefly discuss it again here. The professors listed a variety of obstacles (see Table 371). Some of these obstacles were the financial burdens of attending college; a bad experience in a certain class; and somewhat of a lack of confidence in their ability to do the academic work necessary for graduate school. The researcher is of the opinion that Mississippi students, and indeed students everywhere, likely face many of these same burdens today.

The next question (Question #3) which was posed to the successful Mississippi physicists was the question concerning whether or not they thought that Mississippi students are as well prepared as other students for the academic rigors of physics. A variety of answers were given. To see the full table of themes, refer to Table 371. The most commonly mentioned answer was that the preparation of Mississippi students varies greatly from school to school. The professors mentioned that we have some good schools in the state, and some poor schools in the state. One professor mentioned that we probably have more weak schools than most states. One professor mentioned that he does not think that Mississippi students are as well-prepared as they should be. Another professor highlighted the great importance of a good high school experience. It was also mentioned that there is probably a shortage of physics teachers; it was mentioned that it was hard to get students interested in physics unless they can have experience really doing the things that physicists do.

The fourth question on the interview form for the interview with successful Mississippi physicists was a question which asked them whether or not economic factors play a large part in the choices students make to pursue (or not to pursue) graduate studies in physics. Overall, three of the five professors indicated that economic factors do play a large part in the choices that students make to pursue (or not to pursue) graduate studies in physics; another professor felt that economic factors play some role.

It seems that the economic question (Question #4) was interpreted in many different ways, and so it received a variety of answers. Some professors interpreted it in terms of the job opportunities which exist for physicists. One professor mentioned that the number of jobs for physicists, in recent years, has not been that great. Another professor, in contrast, mentioned that physicists are reasonably assured of getting a job since there are so few physics majors. From a slightly different interpretation of the economic question, it was mentioned that physics (for graduate students) is presently a well-supported field at the University of Mississippi, and so that tends to attract graduate students. From another angle (or interpretation of the economic question), a professor mentioned that there is probably a correlation between economically advantaged backgrounds and more highly educated backgrounds. One professor mentioned that economic factors—the fact that he was offered a relatively high salary—was a principle factor in his accepting a certain scholarship. In contrast to that, it was mentioned that for the same amount of work and talent, students can go into other fields, such as engineering, and come out with higher paying jobs. And, one professor's answer implied that economic factors were not so important, because most physicists probably came from poor backgrounds, many of them farm kids (in the professor's opinion).

Thus, a variety of different answers were given for the economic question; and that was one of the main things the researcher noticed about this particular interview question (Question #4 on the form for the interview with successful Mississippi physicists). It could be interpreted in a variety of ways, and both groups who were interviewed (i.e. the 12 UM physics professors and the 5 successful Mississippi physicists) did interpret it in many different ways. However, overall, it seems that the general consensus was that economic factors do play a role in the choices that students make concerning whether or not to pursue graduate studies in physics. But, there were widely different views of this question, especially when the views of the other 12 UM physics professors are considered. It seems that the question was interpreted in many different ways. The full interview transcripts can show the full context of the questions and answers. The complete theme table (Table 371) for the interview with the 5 successful Mississippi physicists also provides probably a better context for how the professors answered this question. In short, the 5 Mississippi physicists (as well as the other 12 UM physicists) listed a varied mixture of positive and negative economic factors associated with physics.

Question #5 on the interview form with the successful Mississippi physicists asked them to discuss the key factors to their success in physics. The most common items that were mentioned by the 5 successful Mississippi physicists were the fact that they had good teachers along the way (3) and that they worked hard (2). There were a variety of other factors that were mentioned, such as having advanced math classes in high school, and such as having the time to really study physics to learn it rather than just trying to get a grade (as one of the professors mentioned). One professor mentioned that he grew up on a farm doing hard labor, and so he was highly motivated to go to college and obtain an education so he would not have to continue the hard labor. One professor mentioned that he was versatile and worked in a variety of fields. Another professor mentioned the importance of meeting the right people at the right time in his life. Many other themes were mentioned by the professors in their answers to this interview question. Table 371 shows the full list of themes along with how many times they were referenced. The full interview transcripts show the full context of how the question was asked by the researcher and how it was answered by each professor. Also, the researcher (when addressing Research Question #13) has already discussed many of these same factors associated with the success of the 5 Mississippi-native physicists who were interviewed, and how they overcame various obstacles.

The last question, on the interview form with the successful Mississippi physicists, was a question which asked the Mississippi physicists about what could be done to make the Mississippi education system better for producing physics students who would be in a position to have a successful career in physics. A commonly mentioned theme was that the students need better math preparation in the high schools (3). It was also common for the professors to mention that they do not know the full answer for how to do it (3). One professor mentioned that it is not a technology answer, such as giving an entire classroom laptops, but that it is about having solid teachers who can inspire students. It was also mentioned that the math education departments need to have higher standards so that they can produce mathematicians who understand the subject rather than producing people who use fad methods. Another professor mentioned the importance of engaging young students with activities that they can take part in, so that they can do more than just memorize facts and figures. It was also mentioned that we must invest in our high school math and physics students. It was mentioned that economic incentives, such as scholarships and fellowships for students, would be beneficial. It was also mentioned that it would be beneficial to have jobs that students could get once they get the degree. Another professor mentioned that he thinks we do a pretty good job [in Mississippi], especially at certain schools and locations in the state, such as near some of the major universities. Another item which was mentioned was that it would be good if we could have advanced math classes in high school.

There were many items mentioned by the professors for how to improve the Mississippi education system so that it can produce physics students who will be in a position to have a successful career in physics. The full interview transcripts, as well as the "Main Answers" of the professors, show their answers with much greater detail and context. The full theme table (Table 371) also shows the theme categories from the interviews with the five Mississippi-native physicists with greater detail.

Final Summary

This research project spanned several years and required much data collection, as well as careful work in the transcription process. The original data from the graduate schools was fairly difficult to obtain, and the data collection process often required many phone calls and emails. Recording the survey results and calculating the descriptive statistics for the surveys required a massive amount of counting and tabulating. The collection of the audio-recorded interviews required scheduling meetings and driving to various campuses. The research project involved interviewing physics professors from primarily the University of Mississippi (in Oxford, MS), but also from Mississippi State University (Starkville, MS) and the University of Southern Mississippi (Hattiesburg, MS). A total of 17 audio-recorded professor interviews were conducted. Of the 17 physicists interviewed, five were native-born Mississippians. (Actually, one of the five physicists classified as a "native-born Mississippian" moved here as an infant.) The 17 physicists were interviewed in an effort to obtain their collected views concerning physics in Mississippi.

The researcher also needed to schedule the interviews with the ten physics students. These interviews were carefully transcribed, as well. The researcher also needed to collect the survey data from the physics students. Due to the helpfulness of officials in the physics department at the University of Mississippi, the researcher was allowed to collect data for a few minutes at the start of Physics II labs. This was done for five separate labs. Two of the labs were surveyed on July 24, 2012. The other three labs were surveyed on April 24, 2013. There were two Pre-med Physics II labs and three Engineering Physics II labs. There were 38 summer students (or 33.6 % of the total group surveyed); and there were 75 spring semester students (or 66.4 % of the total group surveyed). The researcher intentionally desired to have both engineering physics and pre-med physics students represented in the survey; and, the researcher also intentionally wanted a mixture of summer students and spring semester students to be represented in the survey. This was to try to (rather informally) control for the "time of year" and the "type of physics class." There was a mixture of types of classes and times of year (i.e.

summer and spring semesters) so that neither of these factors would dominate the results, hopefully.

The researcher, once having collected the 113 surveys, had to then tabulate the results. This took much time. Probably the most difficult part of the research process was trying to separate the interview answers and written answers into themes. This was extremely nebulous, but also required an objective spirit—and meticulous work. And, it required the utmost concentration and record-keeping.

Once all of the individual parts of the research had been finished, the researcher put them together into this dissertation. The researcher will now give a final analysis of the findings of this work. Starting with the research questions that were able to be answered, the researcher will try to summarize the main findings. Also, the researcher will touch upon the information gained from the interviews and written responses of the students, as well as some of the information that stood out from the surveys. The survey data represents a large quantity of data which helped answer many of the research questions, but which might also be used by future researchers in other research projects. There are many untapped questions which might arise from a detailed study of the large amount of survey data which was recorded. After having provided a basic summary of the foundational conditions of the research project and how it was carried out, the researcher will now give a condensed summary of the most important findings.

The researcher found that from the Fall semester of 2003 through the Full Summer semester of 2012, a total of 53 graduate degrees in physics were awarded at the University of Mississippi, and 22 of these degrees were awarded to students who were classified as "Mississippi residents." This calculates out to 41.5 % of the graduate degrees in physics being awarded to students who were classified as Mississippi residents. It must be mentioned that in the research process, the researcher discovered that not all students who are classified as "Mississippi residents" were native-born Mississippians (in the traditional sense of being born, raised, and educated in Mississippi). In other words, it is possible for students to move to Mississippi and establish residency before (or maybe during) the time they are attending the university—and the researcher is not certain about the various time frames or legal conditions necessary for this to occur. Of course, as far as the researcher is aware, this is entirely legal (although, the researcher believes that certain legal requirements likely must be met). This particular topic (concerning how many of the "Mississippi residents" were actually native-born Mississippians in the traditional sense) could be pursued no further within the scope of this research project. Thus, the researcher, when determining residency statuses for the statistics involved in this research, limited himself to the official residency statuses as listed in the graduate school records which were provided to the researcher. And, based on the records provided by the graduate school, 22 of the 53 graduate degrees in physics (or 41.5 %) during this time span (Fall 2003-Full Summer 2012) were awarded to students who were classified as Mississippi residents.

The researcher, using data from seven other University of Mississippi graduate degree programs, found that these programs (from Fall 2003 up through Full Summer 2012,) also awarded fairly large percentages of their graduate degrees to out-of-state-students. In terms of the percentage of the graduate degrees of these graduate programs that were awarded to students who were classified as Mississippi residents, the percentages were as follows (from Fall 2003 through Full Summer 2012): Accountancy

(74.4 %), Business Administration (58.6 %), Mathematics (57.6 %), History (55.9 %), English (45.9 %), Physics (41.5 %), Chemistry (37.0 %), and Engineering Science (30.7 %). Thus, the descriptive data for this sample of eight graduate degree programs seemed, overall, to align with the researcher's initial intuition concerning a pattern in which the heavy-math, heavy science subjects seem, as a general rule, more likely to award a lower percentage of their graduate degrees to Mississippi residents. Yet, the researcher was somewhat surprised to see that there were two graduate programs (Chemistry and Engineering Science) which awarded a lower percentage of their graduate degrees to students classified as Mississippi residents than did the physics graduate program.

The data also showed that it has been a fairly common practice—at least among the eight degree programs in this sample—to award relatively large portions of the graduate degrees to out-of-state students (i.e. students who were not classified as Mississippi residents). Thus, upon the analysis of the data, the researcher concludes that awarding large portions of the graduate degrees to out-of-state residents is not a phenomenon which is unique to the physics graduate degree program.

The researcher then expanded the search outward to other states in order to compare other universities' physics degree programs with the physics degree program at the University of Mississippi. Upon analysis of the graduate degree data which was provided by officials at five other universities located around the United States, it was found that overall (during the roughly, though not perfectly, convergent time periods which were studied), the University of Mississippi awarded a higher percentage of its graduate physics degrees to students who were classified as "in-state" residents than any of the five other universities in this research project did. To be more specific, for a roughly (though not perfectly) convergent time period spanning approximately 10 years (see Table 376 for more precise information about the time periods covered), the percentages of graduate physics degrees which were awarded to students who were classified as “in-state” at the six universities in this study were as follows: University of Mississippi (41.5 %), University of Virginia (40.9 %), University of Arkansas (28.1 %), University of Minnesota (25.5 %), Louisiana State University (25.0 %), and the University of Alabama (16.2 %). From this small sample of data, the researcher concluded that the University of Mississippi is not necessarily more comparable to universities of neighboring southern states when it comes to percentage of graduate physics degrees which are awarded to in-state residents. The researcher also concluded, upon observing this data, that the phenomenon of awarding large portions of graduate physics degrees to out-of-state residents is not a phenomenon which is unique to the University of Mississippi. Instead, when observing this small sample, it seems to be the general pattern of universities to award relatively large portions of physics graduate degrees to students who are not residents of that particular state. However, it must be mentioned that before the data can be conclusively generalized as a large-scale pattern, much larger sample sizes (including many more universities) would need to be studied. Yet, there is enough data to conclude that the University of Mississippi is not unique among universities in awarding a large percentage of graduate physics degrees to out-of-state students.

And, indeed, it was a surprise to the researcher to find out that the University of Mississippi awarded a higher percentage of its graduate degrees to in-state residents than any other university in this study. However, the researcher must mention again that not all graduate students who are classified as "Mississippi residents" were actually born and raised in the state of Mississippi (in the traditional sense). Apparently, some students move to the state and then establish residency—perhaps, in some cases, for convenience or for financial reasons. In fairness, the researcher must assume that other state universities and graduate degree programs likely experience a similar phenomenon. The researcher was definitely informed (by a university official) that this happens commonly at the University of Colorado--indeed apparently physics graduate students would be encouraged to change their residency status to “in-state residency” there. The researcher is unsure how common the practice is elsewhere around the country. However, information which was provided by an official at the University of Virginia also implies that graduate students at the University of Virginia might actually be encouraged to apply for in-state residency (see footnotes below Table 30). The researcher must also mention that he was very dependent upon officials at the various graduate schools to supply accurate records; the researcher could not verify the accuracy of these records personally. It must also be mentioned that if the various graduate schools determine residency status in drastically different ways, then that could greatly lessen the comparative value of the results which were found.

The researcher was unable (within the time span and expanding scope of this research project) to answer the general question concerning the proportion of Mississippi high schools which offer physics to their students and whether or not this proportion has changed in time. However, from the survey data of the 113 Physics II lab students, the researcher found that 92.5 % of the “Mississippi Natives” ($N_{MS} = 53$) sample indicated that a physics course was offered at their high school. Also, 58.5 % of the sample of 53

“Mississippi Native” physics students indicated that they took at least one (or in some cases, more than one) physics course in high school. Thus, overall, for the sample of Physics II lab students who were surveyed, the descriptive statistics indicate that the 53 “Mississippi Native” students, for the most part, did have opportunities for exposure to physics in their high schools. (Note: for the student survey portion of the research project, “Mississippi Native” meant that the student was born in Mississippi and received most of his or her high school education in Mississippi.)

The student survey data provided much information concerning the students' physics self-efficacy beliefs. According to Albert Bandura (1997, p. 3), “Perceived self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments.” Some of the survey questions dealt with issues related to how the students perceived their own abilities in math and physics, and how they felt that someone gets good at physics. Indeed, according to Bandura (1997, p. 3), “Beliefs of personal efficacy constitute the key factor of human agency. If people believe they have no power to produce results, they will not attempt to make things happen.” One purpose of the survey questions dealing with “physics self-efficacy” was to try to measure whether or not students felt that they were good at physics (or had the ability to become good at physics).

The results of the student surveys could be analyzed in many different ways. However, some of the main results (based on the descriptive statistics) which relate to physics self-efficacy are as follows. In general, the sample of 113 Physics lab II students believed themselves to be better at math than they were at physics (see Table 383, Table 384, and Figure 6 for more details). Slightly over half of the entire group of 113 Physics

II lab students and slightly over half of the 16 physics professors were of the opinion that the majority of people are not born with the necessary mental capacity to become physicists when they reach adulthood (see Table 387). Yet, the majority of both physics students and physics professors placed a high importance on time spent in study; however, it seemed that for this sample of students and professors who were surveyed, a higher proportion of the professors put more emphasis on natural-born mental abilities (see Table 386). However, these are very small sample sizes, especially the group of 16 physics professors.

Another factor related to self-efficacy was the observation that, in general, the entire group of students who were surveyed (as well as the group of physics professors who were surveyed) indicated that the Mississippi students and the American students were worse in physics when compared to international students. Overall, the Mississippi students were considered (by the entire group and by the professors) to be worse in physics than the general American students; and both of these—the Mississippi students and the general American students—were generally considered to be worse in physics than the international students (see Table 388 and Table 389). Indeed, the "Mississippi Natives" group also rated Mississippi students to be worse in physics than American students or international students are (see Table 388 and 389).

The descriptive statistics from the student surveys portrayed evidence of possible weaknesses in physics self-efficacy beliefs (or beliefs in their ability be good at physics) among some members of the African American sample group (see Table 385), and among some members of the female sample group (see Table 390 and Figure 7).

It was found from the student surveys that roughly half of the sample of 113 Physics II lab students who were surveyed indicated that they enjoy the subject of physics. Roughly one-fourth of the Physics II lab students indicated that they "somewhat" enjoy physics; and the other (roughly) one-fourth indicated that they do not enjoy physics (see Table 391).

Four students (of the 113 students who were surveyed) indicated that they planned to major in physics. A portion of these four students felt that a degree in physics could lead to a wide variety of careers; a portion of these four students felt that majoring in physics would be beneficial to them in their pursuit of a career in medicine; and a portion of these four students indicated that they enjoy problem solving (see Table 392).

There were many reasons students gave for why they chose not to major in physics (see Table 393). Among these reasons was that they were more interested in another subject, major or profession. Also mentioned by some students was that they dislike physics or don't enjoy it; or that physics is difficult. Another point that some students mentioned was that they wanted to choose a major that would be better for preparing them for a career in medicine.

Although there were differing opinions, it seemed that the general consensus of the professors was that Mississippi students are not as well-prepared for the rigors of high-level physics as other students (see Table 400). However, some professors felt that Mississippi students were as well-prepared as the others. Other professors mentioned that some Mississippi graduate students can do well. Also important in this discussion was the point that was made, by at least one professor, that the international students have already gone through a selection process—so that the ones who come here are some of the better students and are competing with a general population of students from Mississippi who have not gone through such a selection process.

As regards the question about what needs to be done to improve the quality of physics education in Mississippi, one of the most commonly mentioned themes by the physics professors was that we need to improve math education. Over and over again, the instructors emphasized the importance of having a proper math background in order to do well in physics. Indeed, one professor (during the interview) made an analogy which illustrated the point that trying to study science without having the proper math language was like trying to study Shakespeare without knowing English. The desire might be there, but without the language, it could not be accomplished properly.

It was also mentioned that we need to recruit qualified physics teachers to teach in Mississippi high schools. Some professors highlighted the need to pay the teachers well enough so that highly qualified physics teachers could be recruited to teach in the schools. Other professors emphasized the importance of cultural factors, like teaching children to value academics, to value science, and to have the proper study habits.

Overall, the majority of the physics professors who were interviewed seemed to have chosen physics as a career because they had a passion for the subject rather than for economic reasons. In terms of obstacles they had to overcome, the Mississippi-native physicists mentioned many things. Among the obstacles which were mentioned was the financial burden of attending college and of being a graduate student. A discouraging experience in a certain class was mentioned. One professor also mentioned that in graduate school, he somewhat lacked confidence in his ability to do the academic work.

When asked to describe why they were successful, some of the things that were mentioned by the University of Mississippi physics professors was that they worked hard and that they had a passion for the subject. It was also mentioned by several of them that they had good academic training. The idea that "one cannot think too much about salaries; one cannot think too much about the time versus money equivalence" was also referenced by two professors in the answers they gave during the interviews.

The native Mississippian physicists who were asked about the key factors in their success also emphasized the importance of hard work and of having good teachers along the way. One professor mentioned that he was able to be versatile; and that he worked in a variety of different fields. Another professor mentioned that his success was not so much as a physicist, but as a physics teacher. Also, it was also mentioned by one of the Mississippi physics professors that the fact that he had heavy exposure to advanced math classes in high school helped him develop a good math background for his college math classes.

One can find more detailed data in the appendix sections of this dissertation. In the appendix, the researcher has included the full transcripts of the interviews with the physicists and physics students. Plus, hundreds of data tables (which contain the descriptive statistics from the survey results) are included in the appendix. Lastly, several extensive theme tables are included in the appendix. These show the results of the qualitative research done by the researcher in the categorization (by themes) of information provided in the interview transcripts and written responses of the physicists and physics students. In the next chapter, the researcher has included some implications of this research for future researchers.

CHAPTER 5: IMPLICATIONS FOR FUTURE RESEARCH

General Overview

In this chapter, the researcher will briefly describe some of the issues which have been highlighted by this research, and some of the implications of the research.
Plus, the researcher will highlight certain questions which were somewhat touched upon by this research project, but which could be pursued more deeply by future researchers. Also, future questions and areas of possible research have arisen in the course of this research project. These are topics and questions which might warrant future research in the field of physics, physics education, or higher education; and some of these issues and questions (for future researchers) would have possible applications to many other academic fields other than physics.

Some Implications of this Research and Some Questions for Future Researchers

This research has highlighted several issues which might be important for future research study. Researchers—particularly in the field of physics, physics education, or higher education—might be interested in conducting further research on some of these topics in order to solidify existing knowledge, to clarify various implications of the research, or to uncover new knowledge in these areas.

Future research possibilities stemming from RQ #1.

The first research question dealt with finding the percentage of physics graduate degree recipients at the University of Mississippi who were classified as Mississippi residents. Using data obtained from the graduate school at the University of Mississippi for the Fall semester of 2003 up through the Full Summer semester of 2012, the researcher found that during that time period, 41.5 % (or 22 of 53) graduate degrees in physics were awarded to students who were classified as Mississippi residents. (This does not mean that 22 different Mississippi residents received degrees, because some people received both a Master's and a PhD degree--this means that such a person would account for 2 of the 22 degrees.) These findings imply certain questions which could be pursued by further researchers:

- Is approximately 40 % an appropriate percentage for the percentage of degrees being awarded to in-state residents from a physics program? What percentage is appropriate for a state-supported institution?
- Perhaps future researchers could pursue such questions concerning the appropriate number of in-state residents in various graduate degree programs at state-supported universities; perhaps future researchers can develop more solid numbers and comparisons with other programs from around the country (and world); perhaps these researchers will also take into account that citizens of some states (with lower costs of living) have arguably a more difficult time attending institutions in other states with higher costs of living.

Also, some of the graduate physics degree recipients who were classified as Mississippi residents moved to the state relatively recently and established Mississippi residency status apparently for convenience reasons, financial reasons, or for some other reason. Thus, although they did obtain Mississippi residence status, these particular students were not actually Mississippi residents in the traditional sense of being born, raised, and educated in Mississippi. Thus, the percentage of graduate degrees in physics which were was awarded to native Mississippians (in the traditional sense of being born, raised, and educated in Mississippi) was arguably much lower than the 41.5 % implied by the official graduate school data.

- Perhaps future researchers could more meticulously pursue the question of exactly how many native Mississippians (in the traditional sense of being born, raised, and educated in Mississippi) are actually receiving graduate degrees in physics.
- Perhaps future researchers in other academic programs other than physics can pursue the question of how many native Mississippians (in the traditional sense of being born, raised, and educated in Mississippi) are receiving graduate degrees in their own particular academic programs. Perhaps future researchers in other states or countries can pursue such questions in relation to the native-born citizens of their own states or countries.
- Perhaps research projects could be designed by researchers to study exactly how many of the students classified as "in-state residents" are actually residents of that particular state, in the more traditional sense of having been born, raised, and educated there. In other words, it would be useful to know just how many students move to a certain state and establish residency soon thereafter—and then enter into

the graduate schools. Such knowledge would be important for the officials of states to know as they attempt to educate the students of their state at the universities.

- Also, perhaps future researchers could try to more deeply understand the question of how residency status data can be misleading and whether or not another residency status category based on "long-term state residency" should be developed in order to better understand how many native-born students of Mississippi (or any other state or country) are being educated by their state-supported institution.

Future research possibilities stemming from RQ #2.

The second research question dealt with determining the percentage of graduate degree recipients in other graduate degree programs at the University of Mississippi who were classified as Mississippi residents. Upon considering the second research question, the researcher found that the percentage of graduate degrees awarded to students classified as Mississippi residents in the Physics graduate degree program was the third lowest percentage (41.5%) out of the group of eight degree programs in this study. With the exception of the Accountancy graduate degree program (74.4 %), all of the degree programs awarded less than 60 % of the graduate degrees to students classified as Mississippi residents. In comparison to the Physics graduate degree program (41.5 %), The Chemistry graduate degree program (37.0 %) and the Engineering Science graduate degree program (30.7 %) awarded even smaller percentages of graduate degrees to students classified as Mississippi residences. These findings imply many areas of possible research in the future. Among these are the following:

- Perhaps future researchers could examine other graduate degree programs (than the ones examined in this study) to calculate the percentage of the various graduate degrees which are awarded to students classified as Mississippi residents.
- Perhaps research studies can be conducted at other universities in many academic areas concerning the question of the percentage of graduate degrees which are awarded to native citizens of that particular state or country.
- Perhaps research can be conducted in order to determine possible causes as to why some graduate degree programs award a larger percentage of graduate degrees to in-state residents than other graduate degree programs.
- Perhaps future research projects could be conducted in order to determine the actual percentages of “in-state” vs. “out-of-state” residents who apply to the various graduate school programs versus the percentages of “in-state” vs. “out-of-state” residents who graduate from the graduate degree programs; perhaps it would be found that a small percentage of “in-state” graduate degree recipients is due to the small number of applicants; or, perhaps one would find that this is not the case; much further research could possibly be conducted on this topic.

When comparing the percentage of Master’s degrees awarded to Mississippi residents versus the percentage of PhD degrees awarded to Mississippi residents, one finds that with the exception of the English graduate degree program, the graduate degree programs which were included in this study all awarded a lower percentage of PhD degrees than Master's degrees to students classified as Mississippi residents. This implies a general principle that a smaller percentage of PhD degrees than Master's degrees are awarded to native Mississippians. While this was generally true of the sample of eight programs which the researcher examined (for the time period examined), further research would need to be conducted in many other programs to establish this more certainly as a general rule for other academic subjects at the University of Mississippi. However, this particular research study produced evidence which lends support to the general idea that as one goes higher up the educational ladder (i.e. to higher-level degrees), the percentage of students officially classified as Mississippi residents decreases. These findings uncover more possible areas for future research:

- Perhaps future researchers could examine other graduate degree programs (than the ones examined in this study) to calculate the percentage of the various types of graduate degrees (Master's vs. Doctoral) which are awarded to students classified as Mississippi residents.
- Perhaps research studies can be conducted at other universities in many academic areas concerning the question of the percentage of the various types of graduate degrees (Master's vs. Doctoral) which are awarded to native citizens of that particular state or country.
- If any general principles are discovered concerning the percentage of various types of graduate degrees (Master's vs. Doctoral) which are awarded to native citizens of states or countries, perhaps causes can be searched for to explain this phenomenon.

In the course of the research, the researcher compared four heavy-math, heavy-science degree programs (Chemistry, Engineering Science, Math, and Physics) to four non-heavy-math, non-heavy-science degree programs (Accountancy, Business

Administration, English, and History). Although it was not true in every case, the general pattern was for the heavy-math and heavy-science graduate degree programs to have lower percentages of their graduate degrees being awarded to Mississippi residents. This also brings up further considerations for future researchers:

- Perhaps future researchers can conduct further studies to investigate heavy-math, heavy-science subjects versus non-heavy-math, non-heavy-science subjects in terms of the percentage of graduate degrees which are awarded to in-state residents in each subject area.

If significant differences are found between heavy-math, heavy-science subjects versus non-heavy-math, non-heavy-science subjects (in terms of the percentage of graduate degrees awarded to in-state versus out-of state residents), perhaps future researchers can further investigate the possible causes of these differences.

Future research possibilities stemming from RQ #3 and RQ #4.

The third and fourth research questions dealt with determining the percentage of physics graduate degree recipients at neighboring universities who were classified as in-state residents; and also determining the percentage of physics graduate degree recipients from traditionally high-performing universities who were classified as in-state residents. Upon considering the third and fourth research questions, the researcher calculated descriptive statistics which—at least for these six universities in this research project—showed that the University of Mississippi (during the time periods which were compared) awarded a higher percentage of its graduate physics degrees to students classified as in-state residents than did any other university among the six universities.

However, the sample size (six universities) was very low, and the statistics are only descriptive statistics which can perhaps paint a general picture, at times, but which do not decisively and conclusively prove the statistical significance of the relative percentages. Also, some major uncertainties which could totally change the meaning of the data concern the issue of how the various graduate schools (or the officials at those schools) determine "residency status," as well as the issue concerning the proportion of students who establish residency in the state (of their university) even though they were not born, raised, and educated in the state in the traditional sense; if these two issues differ greatly from state to state (and university to university), then the comparative value of the data would be greatly affected.

Also, the method that the universities use to determine the "Academic Year" can also vary, and possibly affect the uniformity of the data, making it more difficult for researchers to compare the statistics. Plus, in the course of the research, the researcher communicated with one official—from a university which was not, ultimately, included in this study—who said that out-of-state students who were enrolled in their graduate program were actually encouraged to change their residency status. If universities greatly differ in how they determine residency status or how they handle "out-of-state" residency status issues, then the graduate school data concerning residency status could have vastly different meanings. This portion of the research implies many areas of possible future research, including the following:

- Perhaps researchers can examine a much greater sample size of universities around the nation and world in order to reach stronger conclusions about the various percentages of graduate physics degrees awarded to in-state versus out-of-state residents; perhaps similar research can be conducted in other academic subjects.
- Perhaps researchers can more deeply examine how universities determine residency status of the students, and whether or not more consistent rubrics (or more consistent research questionnaires) could be developed by researchers which would allow them to more consistently and accurately compare the various percentages of graduate degree recipients (by residence status).
- In studying these residence status rubrics, perhaps researchers could continue to study the question of "long-term residency" versus "recently acquired residency status" in order to more accurately measure the percentage of students who were actually born, raised, and educated in a certain state (i.e. in order to account for the number of native-born residents of the state versus the number of citizens who moved to the state and then established residency around that time).
- Perhaps researchers can develop studies to determine which percentage of a state's native graduate degree recipients (i.e. native residents who have graduate degrees) received their graduate degrees from out-of-state universities rather than from in-state universities. Such studies could be conducted in physics, but also in other subjects.

The researcher also found that the descriptive statistics of the University of Mississippi, in terms of the percentage of graduate physics degrees awarded to students classified as in-state residents, more closely resembled the statistics of two "high-performing" universities (from other geographical locations in the U.S.) rather than the statistics of three neighboring "Deep South" universities which were included in this research study. More specifically, the statistics of the University of Mississippi most closely aligned with the statistics of the University of Virginia, in terms of the percentage of graduate degrees awarded to in-state residents. However, this is not a strong conclusion at all, especially considering the possibility that the University of Virginia might actually encourage students to apply for "in-state" residency (see note below Table 30). Also, the sample sizes were extremely low. Ultimately, the researcher feels that the same great uncertainties which were previously mentioned—such as uncertainties or differences in how residency statuses are actually determined at various universities—would greatly temper any conclusions that one could make from this portion of the research. Researchers could pursue further research on this topic in order to try to reach stronger conclusions:

- Perhaps researchers could conduct research studies, using much greater sample sizes, which could possibly detect whether or not there are significant regional differences in the percentage of graduate physics degrees awarded to in-state residents; perhaps similar research could be conducted in other countries; and, if regional differences are definitely discovered, perhaps the causes could be further investigated by researchers.

Future research possibilities stemming from RQ #5.

Although the researcher was unable to fully address or give definite answers concerning the fifth research question (which was concerned with determining the proportion of Mississippi high schools which offer physics to their students and whether or not that proportion has changed dramatically over time), the researcher did obtain some survey data which might partially (and rather indirectly) address peripheral aspects of this question. For example, according to the survey results of the 53 “Mississippi Native” physics students, 92.5 % answered “Yes” when asked if physics was offered at their high school. Furthermore, the survey results showed that 58.5% of the sample of 53 “Mississippi Native” physics students indicated that they took at least one (or in some cases more than one) physics course in high school. Thus, apparently the great majority of students in the sample of “Mississippi Native” physics students went to high schools where a physics course was offered. However, this says nothing of the quality of the physics courses—in the sense of whether or not qualified teachers were teaching the courses. Also, this particular research study examined only 5 Physics II labs which contained a total of 53 students in the “Mississippi Native” sample; and, the students in this particular “Mississippi Native” sample represented a select sample of students who had already made it to college and who had passed Physics I in college, presumably. So, one could not use data from this sample to draw very strong conclusions upon the larger population of students in Mississippi. There are many avenues of research which could be pursued by future researchers upon this portion of the research study:

- Perhaps future researchers could determine with much greater precision the proportion of Mississippi high schools that offer physics to their students and whether or not this proportion has changed dramatically over time.
- Perhaps future researchers can also determine the percentage of Mississippi physics teachers who are certified to teach physics; perhaps this could help better measure the quality of the physics teaching that goes on in Mississippi high schools.

- Perhaps future research could be conducted concerning the various level of degrees (such as Master's, Specialist, or Doctoral degrees) which have been obtained by those physics teachers who are certified to teach physics in Mississippi.
- Perhaps future researchers could continue to more broadly study the relationship between high school physics exposure and later success in physics, whether in Mississippi or in other states and nations.
- Perhaps more detailed and precise measures of “high-quality high school physics exposure” versus “low-quality high school physics exposure” could be researched.

Future research possibilities stemming from RQ #6.

In order consider the sixth research question (which concerns the physics self-efficacy views of students at the University of Mississippi), the researcher had to analyze a tremendous amount of survey data. Although this list is likely not exhaustive, the researcher did find several aspects of the research findings which would warrant further research. For example, the survey results imply that most of the students who were surveyed feel that they are better at math than they are in physics (see Figure 6). Yet, it was very common for the physics professors who were interviewed to express the idea that math education needs to be improved and that success in physics depends on having good math ability.

- Perhaps future researchers can study this apparent disconnect (or difference) between students’ perceptions about their ability in math versus their ability in physics; perhaps futures researchers can determine possible causes for why physics students (at least the ones in this research study) rate their own math ability to be greater than their physics ability.

- Perhaps future research can be conducted to determine some of the deeper causes behind the fact that students apparently view themselves to have less ability in physics than in math.
- Perhaps future researchers can more deeply and precisely determine whether or not it is the actual concepts of physics (rather than the math) which is troubling to many students.
- If researchers discover that the students struggle to understand the concepts of physics—or struggle to apply the concepts properly with the math—perhaps future researchers could investigate a myriad of reasons which might explain the students' difficulties, such as time concerns, pace of the class, volume of material to be covered, outside distractions, inability to digest the material in the book, poor study habits, and so forth; perhaps future researchers could search for other reasons which might help explain why many students have difficulty understanding the concepts of physics.

The researcher also found that some students apparently view their own ethnicity groups to be worse at physics when compared to other ethnicity groups. There was also evidence which suggested that at least one ethnicity group viewed their own ethnicity group to be relatively better at physics than other ethnicity groups (see Table 387). These findings could lead to important areas of possible future research into the physics self-efficacy beliefs of students:

- Perhaps future research can be conducted with greater sample sizes and with more detailed statistical analysis in order to determine whether or not their are significant differences in the physics self-efficacy beliefs of students who belong to different ethnic groups.
- Perhaps future researchers can conduct a wide variety of studies in order to more closely examine the topic of physics self-efficacy beliefs as it relates to physics students' perceptions of their own ethnic group's general competence in physics; perhaps researchers can conduct further studies in order to determine whether or not poor physics self-efficacy perceptions (in relation to ethnic populations) can negatively affect the actual performance (and motivation) of students who belong to various ethnicity groups; perhaps researchers can conduct research on the topic of how to help students develop more positive self-efficacy beliefs in physics.

Another question, which related to self-efficacy beliefs, was whether or not natural-born mental abilities were more important for becoming a good physicist when compared to hours of study in the field. Overall, it seemed that the student groups which were surveyed had mixed perceptions on this topic—the percentages which rated deep study as being the deciding factor were roughly equal to the percentages which felt that a mixture of study and natural abilities was necessary for someone to become good at physics. It was notable that the professor group seemed to place a bit more importance on natural-born mental abilities than did the student groups. However, the professors also placed great emphasis on personal study—and only 25% seemed to indicate (when forced to answer such a question on the survey) that natural-born mental abilities were more important than either much studying of physics or a combination of study and natural-born abilities.

- Perhaps future researchers can examine more deeply the topic of how students (and professors) perceive the "nature vs. nurture" debate when it comes to someone becoming a good physicist; perhaps researchers can use greater sample sizes and perform more sophisticated statistical analyses in order to find out if there is any correlation between how one views the "nature vs. nurture" debate and how proficient one is in physics.
- Perhaps researchers can also investigate the topic of whether or not some of the professors' apparent tendency to place a higher emphasis on natural-born ability came after years of experience of working in the field—or instead was the view that had always been held by that particular person.

Many other topics related to self-efficacy could be pursued by future researchers, such as the physics self-efficacy of the citizens of certain states or countries; or such as the physics self-efficacy beliefs as it relates to genders. For example, the results of the surveys showed that a much larger number of respondents (both male and female) perceived males to have better mental ability for physics. Indeed, even a fairly large sample of the female sample group felt that males had better mental abilities for physics. The topic of science as it relates to gender seems to have already garnered much research in science education, yet it seems that much more research could be conducted on this topic. Ultimately, the survey results provided data which could be used as a basic foundation to launch much further research in the topic of physics self-efficacy. For example:

- Perhaps future researchers can perform more detailed studies (with greater sample sizes) on the self-efficacy beliefs of the citizens of various states and countries (or even geographic regions).
- Perhaps future researchers can perform surveys with greater sample sizes to determine with greater precision the percentage of females who have negative physics self-efficacy beliefs.
- Perhaps future researchers could continue to perform research to discover the deep reasons behind why many females have negative physics self-efficacy beliefs.

Future research possibilities stemming from RQ #7.

The seventh research question dealt with the question of whether or not students at the University of Mississippi have any commonalities in attitudes toward their self-efficacy beliefs in physics as students from other states or countries. One commonality that the researcher found with other research studies was the fact that some students in the University of Mississippi study and some students who were described in other research studies described physics as being difficult. Another commonality, with other research studies, that the researcher looked at particularly closely was the negative views which some females seem to have in relation to physics or in relation to their own physics self-efficacy. The Kessels et al. (2006) article in the *British Journal of Educational Psychology (2006),* 76 (pp. 761-780) discussed many of these issues related to the negative views that some females hold toward physics. Of course, more research could be conducted on this topic in the future:

- Perhaps future researchers could continue to focus research on the topic of the views in females in physics; perhaps further literature reviews could be performed in an attempt to find other commonalities between the results of this particular study (at the University of Mississippi) and other research studies.
- Perhaps the topic of "what makes physics difficult" could be studied further; the researcher found some information related to this topic in the original literature review, such as the study by Ornek et al. (2008), but it seems that there is room for much further research, as well as much more detailed literature reviews.

Future research possibilities stemming from RQ #8.

The eighth research question was concerned with whether or not Mississippi students enjoy the subject of physics, and whether or not their answers to this question showed commonalities with the views of students from other states or countries. The researcher found that overall, nearly half of the students in the survey (conducted at the University of Mississippi) did indicate that they enjoyed the subject of physics; and roughly a quarter of the students in the survey indicated that they "somewhat" enjoy the subject of physics. Roughly another quarter of students in the survey indicated that they do not enjoy the subject of physics. However, overall, it could be said that the majority of students in the study at the University of Mississippi indicated that they either enjoy or somewhat enjoy the subject of physics. The generally positive views of physics which were held by students in the University of Mississippi study seemed to be in contradiction with some of the findings from another research study which found that physics was "significantly less popular than all other subjects" (Taconis & Kessels, 2006, p. 1121). Yet, there were great differences in the samples of students being surveyed, such as the fact that the students described in the Taconis & Kessels study were Dutch 9th graders whereas the students in the University of Mississippi study were college physics students. Much future research could be conducted into the views of students concerning whether or not they enjoy the subject of physics.

- Perhaps future researchers can conduct further studies, with greater sample sizes and more comparable sample groups, into the issue of whether or not students from around the world enjoy the subject of physics; perhaps the reasons why or why not could be further investigated.

Future research possibilities stemming from RQ #9.

Upon considering the ninth research question (which was concerned with the reasons that students at the University of Mississippi give for pursuing or not pursuing physics degrees), the researcher found that only a few students in the survey sample did choose to major in physics, and they did so for a variety of reasons among which were that they enjoy problem solving; that a major in physics could lead to a wide variety of careers; and that a physics major would be beneficial for them as they pursued a career in medicine. The researcher also found many reasons why students chose not to major in physics. Among these were the fact that they were more interested in another subject, major, or profession; the fact that they dislike physics or don't enjoy it; the fact that physics is difficult; the fact that career/job prospects are better in another field; the fact that they felt that another major would better prepare them for a career in medicine; and a variety of other reasons. The researcher believes that much future research could be conducted in some of these areas. For example:

- Perhaps future researchers could find much greater sample sizes of students who chose to major in physics, and then conduct detailed research into the reasons why those students chose to major in physics; for example, there seems to be some connection between medical pursuits and physics, and perhaps this connection could be highlighted in an effort to attract talented students into to the field of physics—future research could possibly be conducted to shed more light on whether or not highlighting this medical connection would be an effective strategy for attracting talented students into physics.
- Perhaps future researchers could conduct further research into many of the negative perceptions which might cause students not to major in physics; perhaps further research could be done to determine which negative perceptions were based upon real factors and which (if any) might be based upon misconceptions about physics or physics careers; also, if future researchers find that many of the negative perceptions have a basis in real conditions, then perhaps this could spur officials in the field of physics to see what could be done (if anything) to rectify any negative perceptions (or negative realities) which might exist.

Future research possibilities stemming from RQ #10.

The tenth research question dealt with the issue of whether or not there are similarities in the physics self-efficacy views of physics instructors and the physics self-efficacy views of students at the University of Mississippi. Many issues were looked at, and a detailed discussion of the findings was given in the "Ch. 4: Discussion of Results." Overall, it can be said that some of the survey results provide evidence which indicates that the physics instructors might place a slightly higher importance upon natural mental ability (when it comes to being good at physics) than did the physics students in the survey sample. However there are several mitigating factors to this conclusion—such as the fact that the questions on this topic somewhat forced the survey respondent to choose among clearly defined answer choices when in reality, the true answers might not necessarily be so "black and white" (i.e. clearly defined). Plus, there were only 16 professors in the sample of physics instructors surveyed which is a small sample size. Thus, one cannot likely make strong conclusions or generalizations based upon the descriptive statistics of small sample sizes. A more detailed discussion of this was given in the "Discussion of the Results" section. Another important survey result was that the professors, to a much larger percentage than the students, indicated that females and males have the same mental ability in physics. Again, although these findings may serve to trigger future research, the sample size of instructors was low and must temper any strong conclusions that we could make about physics instructors, in general. The continuance of research on these topics would be very useful. For example,

- Researchers, using much larger sample sizes, could design detailed studies meant to determine the difference in the lifelong attitudinal views and physics self-efficacy views of physics instructors when compared to general populations of physics students.

- Perhaps future researchers could study with more detail various research topics related to a person's beliefs about the importance of natural mental ability versus the importance of long hours of study as it relates being good in physics; perhaps researchers could design studies to determine whether or not such beliefs significantly affect one's academic trajectory as it relates to being good in physics.

Future research possibilities stemming from RQ #11.

The eleventh research question dealt with the opinions of physics professors at the University of Mississippi concerning the problems that are faced by Mississippi students in physics. Overall, it seems that a majority of the 12 University of Mississippi physics professors/researchers who were interviewed feel that Mississippi students are perhaps less prepared for graduate-level physics than students from other places. However, there were mixed views on this, and there are several mitigating factors (see "Ch. 4: Discussion of Results") that must be considered before any strong conclusions can be reached. The physics professors/researchers who were interviewed mentioned some of the following items [which will likely be problems for Mississippi students]: a lack of preparedness, a lack of preparation and foundational knowledge (such as in math), competition with students from other countries, and the fact that students who come from other countries have already gone through a "pre-selection" process which most Mississippi students do not have to go through. These issues (and others) were discussed more thoroughly in the "Ch. 4: Discussion of Results (with Summary Tables)" section. However, the findings do raise topics for future research:

- Perhaps more such interviews can be conducted across the state (and in other states or countries) to develop a fuller understanding of views among physicists and the recommendations they give for improving physics education.
- Perhaps future researchers in the field of physics, physics education, and higher education can look deeply into the differences (and possible inequities) faced by local students who are competing with international students in graduate programs, especially fields which require great amounts of prior knowledge and preparation.
- Perhaps future researchers can continue to work with physics professors, education professors, higher education officials, and state education officials to design ways to create better preparation among Mississippi students so that they will be ready for the rigors of high-level physics or high-level math courses; perhaps researchers in other states and countries can also conduct similar research into these issues which will apply to their states and countries; ultimately, such research can be conducted on an international basis, as well.

Future research possibilities stemming from RQ #12.

The twelfth research question dealt with the opinions of physics professors at the University of Mississippi concerning how Mississippians can improve physics education in the state. On the survey form which was turned in by 16 professors, some short-answer written questions were included. The sample of 16 professors who turned in survey forms was obtained from a slightly larger group of University of Mississippi physics professors/researchers which also contained two physics professors from Mississippi State University and one from the Univ. of Southern Mississippi. Since the forms were meant to be anonymous, the researcher is not 100% certain in all cases of whether or not a certain professor turned in a survey form. This sample was discussed more thoroughly in previous parts of this dissertation. Tables of the written responses of these physicists provided many different answers (see “Ch. 4: Discussion of the Results”). However, among the responses that were most commonly mentioned was the need to improve math education (or to provide better math preparation); also, an important factor that was often mentioned was the need to recruit qualified physics teachers in Mississippi high schools (the need to provide better physics preparation in high school). The need to improve education/science education of young children, and of children in elementary or middle school was also commonly referenced.

The interviews of the 12 University of Mississippi physics professors/researchers were also analyzed by the researcher, and they provided many answers to the question of what can be done to make the Mississippi education system better for producing highly skilled science and math students. Among the commonly mentioned themes from the interviews were the need to increase the number of highly qualified high school physics teachers; the need to improve the level of teaching in school by the teachers who are there; the need to put more focus on cultural factors in the community and at home which cause students to more highly value science and academic pursuits; the need to pay teachers decent salaries; and a variety of other responses which are more fully discussed in the “Ch. 4: Discussion of Results” section. These findings have implications that can apply to future research:

- Perhaps future researchers can continue to research the problem of providing qualified physics teachers in the high schools, because it seems that the problem is far from being solved.
- Perhaps future researchers can continue to research the problem of providing possibilities for high-level math education in high schools, because this seems to be an often-referenced deficiency that was mentioned by the physicists.
- Perhaps future researchers can continue to do research which is aimed at improving the early science education of young children or middle-school youth.
- Perhaps future researchers can continue to conduct research which is designed for better understanding the processes which cause students and communities to more highly value science and academic pursuits.
- Perhaps continued research can be conducted into the economic factors which affect the pay of teachers, as well as other factors which might attract qualified teachers into the high schools.

Future research possibilities stemming from RQ #13.

The thirteenth research question dealt with the opinions of successful native Mississippi physicists concerning difficulties faced by Mississippians in physics and how these difficulties can be overcome. Five physics professors were interviewed for this portion of the research. Among the many themes which were referenced by the native Mississippian physics professors as being obstacles that they had to overcome were: having a discouraging experience in a certain professor’s class, having to quit work so the studies could be attended to properly; the financial burden of college; the lack of confidence about the ability to do the academic work; and a variety of other themes (see Table 404). In reference to whether or not Mississippi physics students are prepared for the academic rigors of physics, some of the responses mentioned (or themes referenced) by the native Mississippian physics professors were: that the Mississippi students' quality of preparation varies greatly from school to school (and that we have some great schools and some poor schools); that we (in Mississippi) probably have more weak schools than most states; that it was suspected (by the professor) that we might have very few physics teachers which means that there are few students who take physics in high schools; that the Mississippi students (in one professor's opinion) are not as well-prepared as they should be; and that it [the Mississippi students' academic preparation for the rigors of physics] is something that would be nice for the state to improve; and a variety of other responses or themes (see Table 405).

And, when the native Mississippi physics professors were asked about the key factors in their success, the most commonly mentioned factors were having a good teacher (or teachers) along the way and working hard. However, many other interesting reasons were listed such as having the time to really study physics as an undergraduate and graduate student (and not just for a grade), and the choice to not get married while being involved in the rigors of study. Many of the other reasons which were mentioned are shown in Table 406, and a more detailed discussion of the sample and their responses can be found in the "Ch. 4: Discussion of Results" section. Such interviews can be conducted and analyzed by future researchers. The interviews of the native Mississippi professors can have implications for future researchers in many ways, including the following:

- Perhaps future researchers can continue to conduct research (via interviews and surveys) of other native Mississippi professors in an effort to get larger sample sizes.
- Perhaps future researchers in other states or countries can conduct similar research in an attempt to find commonalities with the small sample of native Mississippi physics professors or in an attempt to improve physics education in their own states or countries.
- Perhaps future researchers can look more deeply into the negative effects of having to work while going to school; perhaps they can pursue solutions to this problem.
- Perhaps future researchers can look more deeply at the often troubling economic conditions faced by some graduate students, as well as the tremendous time conflicts which can arise.
- Perhaps future researchers can continue to work among Mississippi students to design ways to improve their academic preparation for the rigors of physics.
- Perhaps future researchers can continue to study the benefits (which one professor mentioned positively) of not just talking to students about physics, but letting them do the things that physicists do.
- Perhaps future researchers can continue to examine the efficacy of studying (for the sake of learning physics) versus the efficacy of studying (to obtain a certain grade); perhaps future research can be conducted into the proper mindset and attitudes which are necessary for successful work in physics.
- Perhaps future researchers, in Mississippi physics education, can conduct detailed studies to find out whether or not we actually have enough physics teachers in the state; perhaps studies into the quality of physics teaching can be conducted, as well.

- Perhaps future researchers can continue to research the topic of what makes a high school physics teacher really effective.

Future research possibilities stemming from other general research material.

Of course, the large amount of information in the surveys and interviews of this research project provided much more material for future researchers than just the items that have been discussed in response to the thirteen research questions. The researcher has included all of the transcripts of the interviews with the professors and students in the Appendix section. Plus, the large collection of information (data tables) which were obtained from the surveys of the students and professors is also included in the Appendix. In the Appendix, one can also find the more extensive theme tables which were produced by a thematic analysis of the main answers from the interviews with the physics professors/researchers and students. The theme tables which were produced by analyzing the written responses of the instructors and students (to the survey questions) are also included in the Appendix. From this large collection of research data, future researchers could find many items which would imply the need for future research. An exhaustive list of all of these potential avenues for future research will not be listed here, but a few of them are as follows:

- Perhaps future researchers can continue to look more deeply at the different physics self-efficacy attitudes of A-students, B-students, and C-students.
- Perhaps future researchers can continue to search for any similarities and differences among the physics self-efficacy views of Mississippi students and American students in contrast to views of international students.

- Perhaps future researchers can pursue future research to find differences and similarities between the physics self-efficacy views of pre-med physics students (i.e. students who are preparing for medical-related careers) versus engineering physics students (i.e. students who are preparing for science or engineering careers); such information would likely be of special interest to college physics instructors.
- Perhaps future researchers can conduct further research into many of the reasons that students chose their major.
- Perhaps future researchers can more deeply study the factors that help encourage students to develop a passion for physics (and science, in general).
- Perhaps future researches can continue to design research to better understand many of the economic factors which encourage or discourage students to pursue careers in physics.
- Perhaps future researchers can study the organizational factors which might be necessary to encourage better communication and coordination between the high schools, universities, higher education officials, and state education officials.
- Perhaps future researchers could examine practical ways to implement many of the suggestions for improving physics education which have been offered by the physics professors and researchers.

Conclusion and Recommendations for the Future

At the close of this research project, the researcher has a better idea of the general picture of physics in Mississippi. The researcher conducted a broad search in an effort to discover the views of Mississippi physics professors and physics students, and to also understand more about the graduate school data in an attempt to understand how many Mississippians were actually obtaining graduate degrees in physics over the years. All of the research into these questions has helped solidify the picture of physics in Mississippi, in some ways. And yet, in other ways, many more questions remain. The most troubling idea, for the researcher, is that it seems that few truly native-born Mississippians are receiving graduate degrees in physics at the University of Mississippi—and physics is one of the highest academic subjects. How can the Mississippi education system be deemed to be completely successful if it does not produce at least a decently large number of truly skilled native-Mississippian physicists? This was the question which had arisen in the researcher's mind before this research project had begun, and it still remains today.

Nevertheless, the researcher now feels slightly more secure in the knowledge that of the universities which were compared in this study, the University of Mississippi was the university which awarded the highest percent of its graduate physics degrees to in-state residents. Yet, the researcher still feels that the number of Mississippians—truly native-born Mississippians—who obtain graduate physics degrees is very low.

It seems apparent, after discussing the issue with professors, that two of the main things which would help the Mississippi education system produce more highly-skilled physics students would be to have better math preparation in the high schools, and to recruit highly-qualified physics teachers for the high schools. The researcher also feels that some of the best talent in Mississippi tends to be drawn toward the medical fields rather than into physics, one of the most important sciences. Would there be a way to draw more of the state's talent into physics departments?

During the course of this project, the researcher kept a log of various ideas for recommendations which might be helpful for producing a larger pool of talented physics students in Mississippi—as well as a more highly skilled group of physics students. Some of these ideas and recommendations of the researcher are listed below:

- Continue to market the B.A. physics major for pre-med students.

It seems to the researcher that many students are interested in medicine and in the medical fields. Thus, if physics can truly be made to appeal to these students and to truly apply more strongly to the medical field, more talented Mississippi students will likely be drawn into the physics department.

- Fund scholarships or assistantships for the B.A. physics (medical emphasis).

These medical-related physics majors might be the most realistic way to attract talented Mississippians into the realm of physics, because many talented students are very interested in the medical field. Some of these students might not obtain entrance to the medical programs or some might ultimately fall in love with physics and thus continue their studies in physics.

- Develop a "Biophysics major" or emphasis area which could lead to a career in medicine or a career in physics.

Many students tend to choose majors that give them more than just one option. Having a major that is designed to appeal to "two options" would likely be very appealing to students. The "Biophysics major" (or emphasis) would ideally have a strong biology and chemistry component in order to heavily prepare the students for the MCAT while also preparing them for a career in physics or medical physics. Many students choose majors which will help them in their attempt to get into medical school.

- Develop and emphasize a pathway for physics teacher certification among physics majors which could lead to a career in physics or in physics teaching.

This might require collaboration with the school of education. It would be another case of creating a major that gives students more than just one option. Plus, it might fulfill the role of supplying a more highly trained pool of physics teachers in the state of Mississippi. Perhaps a physics faculty member in the field of physics education could be devoted to be the head of such a program.

- Develop more “hybrid” courses meant to develop the necessary math skills in talented students who are seriously interested in physics.

These hybrid courses are needed at the undergraduate and graduate level. These courses could teach such topics as vector manipulations, matrices, differential equations, special functions, and practical calculus (as it applies to common physics problems at the undergraduate or graduate level).

- Perhaps an “Applied Physics” pathway to engineering jobs might be developed.

If an “Applied Physics” pathway to engineering jobs could be installed, this might draw many students who are interested in the job opportunities and the applications which are associated with engineering majors. Collaboration with the engineering school might be required. Would it be possible for a pathway to be developed for such “Applied Physics” majors to receive a P.E. (professional engineering) license?

- Adding a "conceptual physics" class (maybe as a pre-requisite for physics, or as an elective) would be helpful.

The lack of emphasis on the concepts of physics was mentioned by at least one student. The extra conceptual material might help students better understand how to apply their math skills to physics problems.

- Perhaps some preparation for the Physics GRE could be offered to undergraduate physics students (similar to Kaplan courses for MCAT, LSAT, and so forth).

This might help the physics majors from the University of Mississippi increase their level of competitiveness when applying to graduate school.

- Teach general physics in three or four semesters (like calculus is often taught) instead of in two semesters.

This would allow teachers to be more thorough in their presentations and not feel the need to rush through important material. It would also, ideally, give the students the necessary time to thoroughly read and digest the material.

- If possible, continue to work with state officials in the hope of developing more state-funded jobs for physics majors.

In general, programs such as the NASA space program would likely be a very good engine for producing such jobs. Perhaps other programs like these can be developed. Perhaps newly created physics research programs could be funded by the state in order to foster an increase in knowledge and in order to continue to create a pool of highly talented physicists in the state of Mississippi.

- Hire a physics educationalist (or a physicist with an interest in physics education) to work as a liaison between the education department and the physics department so that more highly trained high school physics teachers can be produced.

This person would understand the requirements necessary for students to become certified high school teachers. This person could also have the responsibility of working with physics graduate students (via tutoring and so forth) to continue to improve their understanding of fundamental math and physics theorems necessary for making the transition from being a physics undergraduate student to being a student ready for advanced graduate studies in physics. This person could also serve as a physics tutor for students, a lab teacher, and a general physics teacher, if an extra teacher was needed for that subject.

- Create a university/state partnership committee composed of physicists, mathematicians, educationalists, and state education officials. The purpose of the committee would be to improve math and physics education in Mississippi.

This committee could meet periodically in order to continue to work on ways to practically implement the main two recommendations of the physics professors: (1) improving the math preparation of the Mississippi students and (2) increasing the number of highly qualified physics teachers in the Mississippi high schools. They could also work on implementing any other solutions to the problem of improving math and physics education in Mississippi.

Most of the ideas and recommendations (listed beside the bullet-dots in the previous recommendation list) are thoughts which have occurred to the researcher during the course of the research; or upon reflection from personal experiences; or upon reflection from studying the suggestions of others (such as the professors who were interviewed or such as the authors who wrote various articles). The researcher fully realizes that many of the ideas and recommendations in the previous bulleted-list might not be practical for various reasons. Plus, the list is not an exhaustive list; there are probably many other ideas or recommendations which the researcher could add to the list.

However, the previous bulleted-list does contain some of the main ideas and recommendations which have occurred to the researcher (or which have been gathered by the researcher from reading the ideas of other people or from studying the suggestions of others); and so, the researcher would like to add these ideas and recommendations (for possible solutions to the problem of physics education in Mississippi) to the larger body of ideas or suggestions which other people have offered.

Also, as mentioned earlier, many professors emphasized the importance of math preparation. The researcher wishes to highlight again that there might be a slight disconnect between what the physics professors think is good math preparation and what the students think is good math preparation. Large proportions (84 %) of the 113 Physics II lab students who were surveyed stated that they were either “Above Average” or “Excellent” in math (see survey results for Question # 8 of the Student Survey Form). Yet, it seems that the professors feel that math preparation is something which must be worked on. Now, these were Physics II lab students (who had presumably passed Physics I), so maybe they were better in math than the average physics student. Yet, it still seems like there might be a disconnect between the professors’ expectations for being good in math versus the students’ expectations for being good in math. This possible disconnect (if there is one) might be an important problem that could go unnoticed.

Having been involved in several high-level physics classes (and also having been educated in Mississippi public schools), the researcher thinks that in order to really succeed at higher-level (graduate-level) physics, one needs math proficiency (and indeed, meticulous skill) in such “high-math” fields as calculus, differential equations, linear algebra, and so forth. On the other hand, the average physics student who comes into general physics (or engineering physics) and assumes that he or she is “good in math” might be envisioning geometry, trigonometry, and college algebra. Is there some difference between the professors’ standards of being “good in math” and the students’ standards of being “good in math”? If there is a difference in perspectives on this issue, what might be the difference? Are some of the professors (due to having worked in the subject so long and having gained so much skill) thinking of calculus, differential equations, and linear algebra when they describe the need for a student to be “good in math”? Or, are the professors talking about basic math proficiency associated with geometry, college algebra, and trigonometry? Are the students arriving to college with poor geometry, trigonometry, and college algebra skills? Then, why do so many of them see themselves as being “good in math”? Could it be that the students believe that making high grades in math courses in high school qualifies them for being “good in math” in the same sense as physicists view it? Is there a disconnect or incongruency in how physicists view being “good in math” and how students see it? These would be items that would need to be looked into further by future researchers—probably with greater sample sizes, with more precise surveys, and so forth.

Of course, as mentioned earlier, the researcher is also of the opinion (in concurrence with the professors) that students need great preparation in math in order to succeed in physics. Indeed, in order for students to succeed in higher-level physics classes, they need a steep mastery of higher-level math such as calculus, linear algebra, and differential equations—not just trigonometry, college algebra, geometry, and so forth. And, just taking the higher-level classes as a college requirement is not enough, usually, because the courses go so fast, and the time is so short, that real mastery is hard for most students to achieve. Thus, ideally, there would be high school math programs (or courses of study) which would really be dedicated to producing students with the highest level of math mastery that could be obtained by high school students, so that when they entered the physics program, they would already have, for the most part, mastered the math language they need.

Now that the researcher has concluded this research project, he hopes that the information contained herein will be valuable to physicists of today and to physicists of the future. The researcher hopes that this research will be valuable to science educators, also. The researcher was, of course, interested in physics as it specially applies to native Mississippi students who are striving to achieve excellence in physics. And yet, the researcher truly hopes that the information obtained in this research project will be useful to people of any state or nation in the world.

The data obtained from the graduate schools was difficult to obtain and difficult to organize. Prompt organization and planning was required in order to collect the surveys from the students and professors. The interviews had to be arranged, conducted, and recorded. Possibly an entire summer (or more) was spent carefully transferring the audio recordings into text. This required attention to detail, careful listening skills, and the ability to use grammar in the correct way in order to carefully preserve the meaning of the spoken word as it was transcribed into the written word. The survey data was tedious to count up and tabulate. Thousands of tabulations were made—entire nights were spent simply making marks (i.e. tabulation counts) from the various survey results. The separating of the interviews and written answers into quantifiable "themes" was perhaps the most difficult task of all, and it required immense concentration and focus. Lastly, all the separate pieces had to be reassembled in an organized fashion to produce the whole body of work, which is this dissertation.

The researcher hopes that all the information gained through these processes and displayed within this dissertation will be useful to others. Yet, in the opinion of the researcher, the main value of this work is that it contains much valuable historical documentation of physics in Mississippi, including the physics perspectives of students and professors. By the data which was recorded in the tables, and from the interviews of students and professors, a part of the story of Mississippi physics has been recorded for future generations.

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APPENDIX

APPENDIX A: SOME IMPORTANT CULTURAL AND HISTORICAL FACTORS IN MISSISSIPPI SCIENCE EDUCATION

Overview

In 1817, Mississippi was admitted as the 20th state of the United States of America. In its early years of existence, the state of Mississippi contained high number of relatively wealthy planters. In fact, Natchez, Mississippi was once one of the richest geographical areas in the United States. Yet, Mississippi was soon populated by a large number of immigrants from the east. Many of these immigrants were from the Scot-Irish ethnic group. Many of these immigrants were coming west to gain access to cheap land. At the time, immigrants had to travel further and further west to obtain cheaper land, because in the West, the land was not yet densely populated with European inhabitants. For the most part, these Scot-Irish immigrants, who originally came from arguably some of the poorer regions in Europe, apparently did not have a rich academic heritage (Leyburn, 1962; Fischer, 1989; Webb, 2004).

African Americans are another very prominent cultural group in Mississippi. Most African American Mississippians are the descendents of those Africans who were brought to America centuries ago as slaves. They did not have the freedom to choose their own livelihood, and they certainly did not have access to the higher realms of education. They were brought to America (and to Mississippi) in order to serve as agricultural workers. Today, large populations of African Americans in Mississippi can be found in the fertile agricultural regions of Mississippi, such as the Mississippi Delta, where they once tilled the land. They, like the poor Scot-Irish settlers, did not have the advantage of a rich academic heritage in the Western scientific disciplines.

Native Americans inhabited the region, now known as Mississippi, for thousands of years before the Europeans or Africans arrived. However, they were pushed from the land they originally lived upon. Their culture suffered from the affects of forced migrations and from cultural assimilation. Thus, the Native Americans, who (as far as we know) were the original Mississippians, are also at a disadvantage when it comes to physics. Although there are some exceptions, most Mississippians, even to this day, come from a cultural historical background that did not bestow upon them a rich indoctrination into the Western scientific disciplines.

There are also other important cultural groups who have affected the history of Mississippi; such as the early French and Spanish explorers, Chinese workers in the Mississippi Delta, Mexican migrants who have recently moved here, prominent Jewish businessmen, Catholics along the coast, and a variety of other cultural groups. An understanding of these other cultures is also important, if one wishes to have a more complete understanding of Mississippi culture.

The researcher also reviewed much historical literature concerning the topic of Southern Science. In order to fully understand the cultural underpinnings of science education in Mississippi, it is necessary to understand basic historical information associated with science education in the southern portion of the United States known colloquially as "the South."

Science and Southerners

In the past, there have not been many famous scientists who have originated from that southern region of the United States, known as the South. In the 20^{th} century, the widely known journalist, H.L. Mencken, made fun of the South as being a vast desert when it comes to intellectual things. It is probably true that the South has not yet produced its fair share of world-renowned physicists, chemists, and mathematicians. However, the Southern people—whether they be the Native American Southerners, African American Southerners, Scot-Irish Southerners, or otherwise—had different circumstances than most other Americans. They had circumstances which did not favor progress in the scientific disciplines. There were several factors that worked against the spread of education, among Southerners; among these factors were an "agrarian economic system," "limited urbanization," an "intense spirit of localism," and a "rigid class and caste system" (Urban & Wagoner, 2009, p. 147). There are also other cultural and historical factors, besides these, which must be considered in order to fully understand the educational culture of Southerners. And, as has previously been stated, the factors that affect the educational culture of other Southerners usually affect the educational culture of Mississippians since Mississippi is a Deep South State.

The American South is a region of the United States that has a unique history, much of it centered around the American Civil War (1861-1865). In the years before the Civil War, the eleven Southern States—later to become the Confederate States of America—developed a similar culture. The economy of the Southern states was largely agricultural, with cotton being the foremost product. The European people of the South, for the most part, shared a similar cultural heritage. A large number of the European settlers in the Deep South originally came from Scotland. There is some evidence to suggest that many of them were from the regions of Scotland near the northern border of England; apparently, these people would have been known as Lowland Scots. Scotland was a region that, historically, was considered by many other Europeans to be a rather barren and backward region of Britain (Leyburn, 1962).

In his book *The Scotch Irish: A Social History*, Leyburn (1962) paints a sad—and sometimes comical—picture of the Scottish people who were, ultimately, the ancestors of many European-Americans in the Deep South (including Mississippi). Even in medieval and colonial times, the Scottish people had many of the same traits which many Americans associate with “Hill-Billys” and “Southern Rednecks.” Leyburn gives descriptions of plain-dressed folks who went around barefooted, rarely washed, and lived amongst the squalor of animals. He also described the barren, savage-like quality of the landscape—a land void of cultural luxuries. In his book, Leyburn included the account of one traveler who, after travelling to Scotland, felt like he had visited a savage land. To fully understand Southern culture, one must understand the culture of the Scottish people—especially that branch of the Scottish people which immigrated to Northern Ireland (and later to the USA), eventually to become known as the Scot-Irish.

Ultimately, the Scot-Irish people were a very important component in the group of settlers who eventually settled throughout most of the Deep South, including Mississippi. The researcher is not certain as to what actual percentage of European settlers (in the South) would be considered Scot-Irish. But, based on secondary evidence—like the prominence of common Scot-Irish surnames and the prominence of certain varieties of religion (for example, relatively few Catholics or Anglicans), one can surmise that perhaps the Scot-Irish component is the largest component among the European settlers in Mississippi. However, the researcher cannot prove this with certainty. The researcher can only say that the Scot-Irish component is apparently a very large component in the group of European settlers who ultimately settled Mississippi.

And, upon studying the history of the Scot-Irish more closely, one finds that they were often culturally disadvantaged in many ways.

However, many people do not seem to be quite as aware of certain challenges faced by the Scot-Irish compared with the challenges faced by other groups—such as Catholic Irish immigrants, Jewish immigrants, African immigrants, Asian immigrants, or Native Americans. The Scot-Irish cultural group faced challenges both back home in Scotland (and Ireland), and in their new home in the United States. Although the Scot-Irish have received perhaps less literary coverage than many other cultural groups in the United States, there is a small amount of literature which can be used to document the cultural disadvantages of the Scot-Irish. However, to my knowledge, there are no comprehensive books or articles which discuss, specifically, the disadvantages of the Scot-Irish when it comes to science and physics achievement.

It is important to realize that there were other European settlers besides the Scot-Irish who settled in the South. In Virginia, there was a core group of Englishmen who settled there. A large number of the Virginian upper-class were the descendants of English noblemen who had been given large tracts of land after helping re-establish the monarchy in England. The Church of England, which later became the Protestant Episcopal Church in America, was well-established in Virginia. These Virginians formed a key portion of the elite, upper-class of the South. From them came such famous men as George Washington, Thomas Jefferson, and Robert E. Lee (although Lee also had some Scot-Irish ancestors). During the American Civil War, many of the intellectual and military leaders of the South came from such Virginia gentry. Such prestigious Southern universities as Duke University, and also William and Mary College were established by these Virginia elites.

One must always keep in mind that many of the early Virginia elites were descendents of the English intellectual and cultural heritage, not the Scot-Irish cultural heritage. And, many of these Virginia elites had connections to English aristocracy. On this topic, David Hackett Fisher (1989) said the following:

> The great majority of Virginia's upper elite came from families in the upper ranks of English society. Of 152 Virginians who held top offices in the late seventeenth and early eighteenth century, at least sixteen were connected to aristocratic families, and 101 were the sons of baronets, knights, and the rural gentry of England. (p. 216)

However, apparently, a large number of European Southerners originated from the Scot-Irish cultural group, a group which apparently possessed a relatively poorly developed intellectual cultural heritage.

In the decades preceding the American Civil War, a time period which is often called the "Antebellum years" by Americans, the Southern elites apparently played a large part in influencing the educational forms in the South. Perhaps their culture formed the original inspiration for many of the "classical themes" that can be found within Southern culture in the Old South (a name used to designate the American South as it existed before and during the Civil War). This classical connection, found in Old South literature and Old South architecture, can possibly be explained by the close connection of the English elite and the culture of their mother country, England. However, the researcher has not done the historical research to prove this conjecture with certainty. One thing seems clear, though. It appears that the culture of the English people is much different than the culture of the Scot-Irish people. Hence, when one attempts to understand the differences of various cultural groups in the United States, it helps to review some of the past history of the cultural groups.

The English, who were originally a Germanic people group, actually moved to the British Isles soon after the Romans left the island (which was named Britannia by the Romans). The British—who were a Celtic people—resided in the British Isles long before the English arrived. In fact, it was the British who actually invited the English to immigrate to the British Isles, because apparently the British needed the English to help them fight against other aggressive tribes of the British Isles—at least, this is how the story was told from some perspectives. The researcher cannot yet fully unravel the deep truth behind the true reasons for the wars of that time.

The religion of the British had been greatly influenced by the Romans who, after conquering the island, had administrated it for several centuries. During the time period in which the Romans administrated Britannia, Christianity began to grow more influential amongst the Romans. Many Romans converted to Christianity; their form of the Christian religion later became known as Roman Catholicism. In time, many of the native British, who had resided amongst their Roman administrators, were also converted to Roman Catholicism.

According to the respected English historian known as Bede (or the Venerable Bede), the English people were also converted to Roman Catholicism during the centuries after their arrival to the British Isles. For nearly a thousand years—until the Reformation, which began in the sixteenth century—the official religion of the English people was Roman Catholicism. And, even after the Reformation, the Anglican Church retained a large portion of the tradition (and intellectual heritage) which had been established by Roman Catholicism. Thus, English culture, through its ancient connection with Rome, had long been connected into the stream of classical Greco-Roman themes which are found throughout most of refined Europe. Perhaps some of this culture persisted in the educational values of the “elite” Southerners, many of whom were English (at least, in Virginia). Perhaps this (as well as existent Roman Catholic influences at the time) might explain some of the reasons behind why some Southerners emphasized the value of a classical education; Southern scholars studied Greek, Latin, and the works of the classical writers from Greece and Rome. However, although the researcher has detected an emphasis on classical education in the historical times preceding the 20th century, the researcher cannot say with certainty that such emphasis was greater in the South than anywhere else in the United States.

While some in the Old South had access to the highest forms of European education, most others had little access to education. Discussing education in the Chesapeake and Southern colonies, Wayne Urban and Jennings Wagoner, Jr. (2009, p. 25) said, “Beginning in the seventeenth and continuing through most of the eighteenth century, some planters and wealthy merchants sent their children ‘back home,’ as they referred to England, for a proper education.” Urban and Wagoner (2009, p. 26) go on to say, “Many children of the less cultured members of society, however, had little chance of receiving even the basic rudiments of literary training.”

Despite the fact that the science culture was not strong in the Antebellum South, there is evidence that Southerners were interested in scientific learning. In his book, *The Mind of the Old South* (revised edition), Clement Eaton wrote about the scientific mind associated with the Old South (or pre-Civil War South). Eaton said that usually the science teacher, in the Old South, was “a Northerner or a foreigner” (Eaton, 1967, p. 225). Eaton (1967) also said that the libraries in the Old South were “poorly supplied with scientific works, and the colleges and universities lacked equipment and adequate laboratories for the professors to carry on experiments” (p. 225).

Despite the many cultural factors that militated against the average Southern man becoming a scientist, there were a few Southerners, in the Antebellum years, who became notable scientists. Eaton (1967, p. 226) discussed Mathew Maury, Joseph Le Conte, and William Barton Rogers as notable examples of Southern Scientists—although Rogers was apparently born in Philadelphia and moved to the South a few years later. Maury did notable work concerning the geography of the ocean floor. According to Eaton (1967), Rogers’s greatest work was “a study of the Appalachian mountain chain” (p.227). According to Eaton (1967), the project began when Rogers “persuaded the Virginia legislature to authorize and support a geological survey of the state” (p. 227). Rogers went on to become the first president of MIT (Eaton, 1967). Rogers had a brother, Henry Rogers, who also made important contributions to the study of the Appalachian mountain chain (Eaton, 1967).

Eaton (1967) discussed some of the scientific activities of Joseph Le Conte and his brother John Le Conte. According to Eaton (1967, p. 231), Joseph and John Le Conte were both contributors to the *American Journal of Science*. Joseph published a paper which dealt with the Gulf Stream and the formation of the Florida Keys. John published a paper which dealt with how sound affected a flame; the paper was inspired by the observations he had made on a gas flame while he was at a concert where musical instruments were being played (Eaton, 1967). Such a paper would be of special interest to those involved in acoustical physics at the University of Mississippi.

Frederick A. P. Barnard—who according to Eaton (1967, p. 233) was not a native Southerner, but who was a professor of science in the South—is of special interest to Mississippians since he worked at the University of Mississippi. According to Eaton (1967), Barnard published a pamphlet in 1856 which was called *Improvements Practicable in a Southern College*. Within this publication, Barnard discussed some of his views of science education. Eaton (1967, p. 240) quoted Barnard who was concerned "that the science courses in the college and universities of the United States were usually mere outlines that gave the student only a smattering of knowledge." According to David Sansing (1990), Barnard (who was President of the University of Mississippi) wrote a comprehensive letter (in 1857) to the board of trustees. The contents of the letter included the recommendation for a "radical reorganization of the university" (Sansing, 1990, p. 49). According to Sansing (1990), Barnard comprehensively touched on a wide variety of matters—such as "science and medicine, agriculture, law, classical studies, civil and political history, and oriental learning" (p. 50). According to Sansing (1990), Barnard's letter "was a brilliant defense of pure science that time has done little to damage" (p. 50).

The influence of Frederick A. P. Barnard can still be felt at the University of Mississippi today. There is a building on campus named the Barnard Observatory. Also, there is a placard in the Department of Physics and Astronomy which tells the story about how just before the American Civil War, Barnard had ordered a world-class telescope to be built for the University of Mississippi. However, due to the war, the world-class telescope never made it down South to the University of Mississippi. Barnard's dream of having the telescope at the University of Mississippi was not realized. After the Civil War started, Barnard left Oxford and the University of Mississippi. He went North, later to become president of Columbia University (Eaton, 1967).

Clement Eaton (1967) gave other examples of Southern scientists or of scientists who were not from the South originally, but who did scientific work in the South. The example of these scientists shows that science was possible in the South during the antebellum years. They represent case studies which might help others understand the mind of Southern scientists—then and now. Their stories can serve as inspiration for future Southern scientists or for anyone who is interested in pursuing science.

After the Civil War, however, the South was devastated—militarily, culturally, and economically. Although the researcher cannot say with historical certainty, it seems that Southern students of that time period, for the most part, probably had less opportunities to participate in scientific pursuits than their Northern peers. According to Nancy Smith Midgette (1991, p. 13), "throughout the 1870's southern colleges struggled just to reclaim (or rebuild) their physical plants and to assemble faculties." In Tuscaloosa, Alabama, the "Union troops had burned all of the state university buildings" (Midgette, 1991, p. 13). It took generations for the South to recover from the trauma of the American Civil War. Although the researcher has not had the chance to investigate it meticulously, one would surmise that in the decades after the American Civil War, there was little infrastructure in the South to support the serious pursuit of science. Nevertheless, it would be necessary for Southerners to embrace science, because society was becoming more technical and scientifically oriented.

The years after the American Civil War saw a shift in educational philosophies. There was a de-emphasis of the classics, which had long formed an important part in education. There was a shift to more technical endeavors. According to Midgette (1991), "southern educators were not oblivious to this shift in philosophy concerning higher education" (p. 13). In 1888, the Georgia Institute of Technology was opened in Atlanta; it was modeled after the Massachusetts Institute of Technology (MIT) (Midgette, 1991).

Another development, in Southern science, was the creation of the State Academies of Science. This was a development that Midgette (1991) documented extensively in her book *To Foster the Spirit of Professionalism: Southern Scientists and State Academies of Science*. As the title implies, these academies of science were created in order to aid Southerners in the professional pursuit of science. They gave Southern scientists a place to dialogue with other scientists, and a place to publish their scientific works.

North Carolina was the first of the Southern states to create a state academy of science—not counting the Texas academy of science which was "short-lived," and had to be revived again years later (Midget, 1991, p. 41). According to Midgette, the first official meeting of the North Carolina Academy of Science was in 1902. Approximately ten years later, Tennessee created a state academy of science (Midgette, 1991). By sometime in 1922, the Virginia Academy of Science was in existence. In the years that followed, several other Southern states created their own state academies of science. According to Midgette (1991), the Mississippi Academy of Science, though chartered in 1930, "did not officially convene for the first time until 1937" (p. 67). Midgette's informative book, on the Southern State Academies of Science, lends much evidence to the idea that Southerners have, for many years, desired to conduct science and to improve science education in the South. The creation of the Mississippi Academy of Science demonstrates that Mississippians, too, have made efforts to advance in the sciences.

Despite their past efforts to improve science and physics education, there are still deficiencies that can be detected in the science achievement of Mississippians. To better understand these persistent deficiencies in science achievement, it proved useful to the researcher to conduct a review of the cultural history of Mississippians—especially as it relates to science and physics education. Although there are many different cultural groups who presently reside in Mississippi, this historical part of this research study focused on the cultural and historical backgrounds of three cultural groups in Mississippi which have played an important role in the history of the state: (1) African Americans, (2) Native Americans, and (3) Scot-Irish Americans. Hopefully, a brief look at the cultural and academic history (especially as it pertains to science education) of each of these three groups will provide a stronger foundation for future science educators who wish to develop solutions to improve science and physics education in Mississippi.

African Americans in Mississippi

African American Southerners represent a prominent cultural group in the history Mississippi and in the history of the South. It is vital for one to understand African American culture if one is to understand the culture of Mississippi as a whole. Mississippi contains the highest percentage (37%) of African Americans in the United States (Poulin, 2010). Without understanding the historical educational background of

African Americans, one cannot fully understand science education in Mississippi. Like the Native Americans and the Scot-Irish, African Americans have experienced the disadvantage of having a weak educational background (or few educational opportunities)—when it comes to math and science subjects like physics. For example, according to science education professor L.G. Hanshaw, "some Mississippi black high schools from the 1930's through 1966 did not offer physics" (personal communication, June 13, 2012).

African Americans were first brought to Mississippi as slaves. During much of the South's history, African Americans were not allowed to vote or take part in politics. Thus, they were disenfranchised. Later they gained more freedom and have now entered all realms of the Mississippi community. Like their fellow Mississippians of Scot-Irish heritage, the African Americans came from a region of the world that was less academically advanced. Also, the African Americans were brought—against their will—to a land far away from their homeland. Unlike their Scot-Irish peers, they were not induced by the incentive of land (or economic opportunity) to come to America. They were severed from the culture of their original homeland in Africa. Thus, in a certain way, African Americans had to start from scratch, culturally and educationally, in an entirely new land. It goes without saying that they were at an extreme disadvantage when it comes to academics. African American educationalists, among others, are developing ways for their people to overcome the academic disadvantages that they have faced. Yet, there are still obstacles in education that African Americans are facing. There are obstacles to be overcome in physics education.

For example, according to Susan White and Casey Langer Tesfaye, who wrote a March 2011 online article published in *focus on* (a publication of the American Institute of Physics Statistical Research Center), “In 2009, about 25% of Black and Hispanic high school students in the U.S. took at least one physics course prior to graduation” (2011, p. 1). White and Tesfaye went on to mention that even though the percentage was higher than the 10 % which was measured in 1990, “the physics-taking rate for Blacks and Hispanics is still well below the 41 % of White students and 52 % of Asian students who will take at least one physics course in high school” (2011, p.1). Hence, even though their have apparently been some positive gains, there is still more work to be done to improve physics education for African American students (and Hispanic American students).

There is substantial literature which documents the struggles that African Americans have faced in education. During the early years of their history, they were brought to the United States against their will. It was almost impossible for an African American to get a good education, in Antebellum times. According to James D. Anderson (1988), “during the three decades before the Civil War slaves lived in a society in which for them literacy was forbidden by law and symbolized as a skill that contradicted the status of slaves” (p. 16). Although some African Americans did become literate in the Antebellum South, they often had to brave great hardships in order to do so. Nevertheless, many of the slaves braved the difficulties and became literate, anyway (Anderson, 1988).

After the Civil War ended in 1865, the African American slaves were set free. Their thirst for education was extraordinary. John W. Alvord, the national superintendent of schools for the Freedmen's Bureau, said that the African Americans had begun to form "self-teaching" schools or "native schools" (Anderson, 1988). Perhaps the long years without educational opportunities had made the African Americans much more desirous of such opportunities. In his book, *The Education of Blacks in the South, 1865-1935*, Anderson (1988) included a poignant quote from a former slave: "There is one sin that slavery committed against me, which I will never forgive. It robbed me of my education" (p. 5).

The inequities that African Americans faced, in educational matters, continued for decades after the Civil War. For example, by the mid-1930's, more than 54 percent of southern white children (of high school age) were enrolled in public high schools; less than 20 percent of African Americans (of high school age) were enrolled in secondary schools (Anderson, 1988). According to data tables given by Anderson (1988), in 1915 there were still many large cities in the South that did not have even one public high school for African American young people.

Despite the early obstacles they have faced, there have been a number of African American scientists who can serve as role models for African Americans or for others interested in science. One well-known example of such a scientist is George Washington Carver who worked at the Tuskegee Normal and Industrial Institute in Tuskegee, Alabama. Carver conducted exhaustive experimental research with plants—developing over 300 products that could be made from peanuts and over 100 products that could be made from sweet potatoes (Kessler, Kidd, Kidd, & Morin, 1996). Another example of an African American scientist and educator was Dr. Charles A. Pickett, a former college professor, who earned a Ph.D. in Science Education (Physics) in 1976. In 2009, Dr.

Pickett was officially commended by House Resolution No. 22 of the Mississippi Legislature for his exemplary services to science education in Mississippi. According to House Resolution No. 22 (2009), "Dr. Pickett was instrumental in increasing the number of physics courses offered, the quality of physics courses taught, and the availability of physics laboratory equipment at historically black colleges." The document, authored by Representative Perkins, also states the following about Dr. Picket:

> Dr. Picket joined the staff of the Board of Trustees of the State Institutions of Higher Learning (IHL) where he held numerous positions, including Associate Commissioner of Academic Affairs and Interim Commissioner, becoming the first African-American professional to serve in either of these positions. (H.R. No. 22, 2009)

The career of Dr. Picket served as an inspiration to other young Mississippi scientists who were beginning their careers. Indeed, according to L.G. Hanshaw, "Dr. Pickett taught and inspired many students as a math and physics professor at Mississippi Valley State University in Itta Bena, Mississippi" (personal communication, June 13, 2012). It is important that young people, who wish to embark upon careers in the sciences, have such role models to help them navigate the difficulties they will face.

In the review of the literature on the topic of physics education and science education, the researcher found more information concerning African American scientists than information concerning Native American scientists or Scot-Irish scientists. One good source on the topic of African American scientists was the book *Distinguished African American Scientists of the 20th Century* (Kessler et al., 1996) which contained a large number of biographies of African American scientists. The book resembled a type of "who's who" in African American 20th century science. Interestingly, a large number of these African Americans were from the South, and some—such as Joseph C. Dunbar, Jr. and William R. Wiley—were from Mississippi. The stories of many of these scientists illustrated the determination that was often necessary to be successful in the scientific disciplines. Their stories can be an instrument for all Americans, Southerners, and Mississippians who wish to pursue careers in science. Physics teachers, possibly, can use such books for assigning research reports to foster an appreciation for African American scientists among their students. Throughout the 19th and 20th centuries, African Americans have played a vital part in the story of science education in Mississippi.

Mississippi Settlers Before Statehood

Before the 19th century, there were relatively few African Americans and European Americans in Mississippi. The very first—and sometimes futile—attempts at European colonization in Mississippi did not begin until 1699 when French colonists and soldiers landed near present-day Ocean Springs (Busbee, 2005). All during the 1700's the groups of Europeans—including the French, the Spanish, the English, and later the Americans—formed bases and settlements in Mississippi (mostly along the Mississippi River and the Mississippi gulf coast). These bases often changed hands as the various countries fought wars, won wars, and lost wars—usually wars that were being fought in Europe. Thus, European colonization, in Mississippi, was confused and erratic. In the earliest days of European colonization, the colonists consisted mostly of army officers with their wives and children, along with priests and government officials. However, once the Mississippi territory gained official statehood into the USA in 1817, thousands of European American settlers (apparently, many of them Scot-Irish) began pouring into the newly available land. Some of the European Americans who lived in Mississippi had

African slaves who resided with them. Yet, before the 1700's, it was the Native American Indians who resided upon the land now known as Mississippi.

Native Americans in Mississippi

Apparently, the earliest Mississippians of all were the Native Americans, and they, like most other Mississippians, were at a disadvantage when it comes to education. There is much documented evidence concerning the fact that the Native Americans (also called "American Indians" or sometimes just "Indians") lost access to their land and were transferred westward, often through forced migration. H.B. Cushman, in his 1899 book *History of the Choctaw, Chickasaw, and Natchez Indians*, described his own eyewitness account of much of the misery experienced by the Native Americans in Mississippi. Cushman grew up in close association with Native Americans in Mississippi; he was very familiar with the Choctaw language, and reportedly, he later became familiar with the Chickasaw language (Baca, 2007). Cushman's book, which was later edited and republished by Angie Debo, contains a wealth of information concerning the lives of Native Americans in Mississippi. Although there were other Native American tribes, the three major Native American tribes in Mississippi were the Choctaws (in Central, South, and East Mississippi), the Chickasaws (in North Mississippi), and the Natchez (concentrated in Southwest Mississippi near present-day Natchez).

The Natchez Indians, after defeating the French at Fort Rosalie (near Natchez) in 1729, basically ceased to exist as a tribe when they were defeated by the French in 1732 (Busbee, 2005). A few of the remaining Natchez Indians went to live with the Chickasaw Indians in Northern Mississippi. The Chickasaw, over the course of years, developed a reputation as being an unconquerable, warlike tribe. They fought the Europeans in several engagements during the 1700's. Nevertheless, they, too, lost their original lands. Most of the Chickasaws were long ago removed to reservations in Oklahoma; thus few Chickasaws live in Mississippi today. The Choctaws—who were concentrated in the central, southern, and eastern parts of Mississippi—were generally reputed to be a more peaceful tribe. The Choctaws were also swallowed up in the tide of European settlement. Some of the Choctaws were forced to move to Oklahoma. However, others of the Choctaws stayed in Mississippi where they reside on reservations today (the largest reservation being located near Philadelphia, Mississippi). At the present time, more Choctaws reside in Mississippi than any of the Native Americans from any other tribe.

In his history of the Native Americans of Mississippi, H.B. Cushman (1899) describes how the Native Americans had a thirst for education. In one portion of his book, Cushman describes how in 1819 a Choctaw chief named Apakfohlichihubi gave $200 while "others gave 90 cows and calves" to help support a mission and a school (Debo, 1999, p. 73). Cushman went on to say how the Chickasaws heard of the school and also wanted their children to attend. The Choctaws ultimately allowed the Chickasaws to attend under certain conditions.

Cushman gives another moving example which illustrates the appreciation of the Choctaws for schools and learning. At the commencement (in the early 1800's) of the first session of the Mayhew school (for Native Americans), the Choctaw chief—Moshulatubbee—spoke the following words concerning the new school for Choctaws:

> Such a thing was not known here when I was a boy. I had heard of it, but did not expect to see it. I rejoice that I have lived to see it. You must mind your teachers,

> and learn all you can. I hope I shall live to see our councils filled with boys who are now in this school, and that you will then know much more than we know and do much better than we do. (Debo, 1999, p. 84)

The words of the Choctaw chief show that he was hopeful that future Choctaws would gain knowledge and learning. He realized the importance of education for his people. Cushman gave examples throughout his book which show how eager the Native Americans were to have schools built for their children (Debo, 1999). The Native Americans, of today, are just as interested in education as their forefathers. They, similarly to other cultures, are also interested in achieving competence in science.

In the book *Science and Native American Communities*, edited by Keith James, Native Americans from across the country offer their perspectives of education—especially as it relates to science. James's book offers a unique view into the Native American psyche. Such a book is useful, because Native Americans do not usually have access to the large media forms in order to describe their side of the story (Pewewardy, 2001). Pewewardy (2001) says that science "should not be a privileged field that is limited only to those who accept a particular mythic tradition" (p. 21). He says that science is important for Native American communities and lives. Pewewardy (2001, p. 20) gives a good example of how people can be negatively labeled by others; he says, "instead of calling traditional cultures 'primitive,' we should say they are 'without writing'." It has often been said that stereotypes can cause self-fulfilling prophecies. In other words, people may unconsciously fulfill the expectations that others create for them. That is why high expectations are important. According to Pewewardy (2001), science is important for Native American communities and lives.

Clifton Poodry (2001) says that Native Americans in academics or professional fields can also be stereotyped by members of their own community. This stereotyping, according to Poodry (2001) can "dissuade [Native Americans] from even attempting to engage in community service" (p. 31). Poodry gives the example of how some Native Americans often use the idea—a faulty idea in Poodry's opinion—that Native Americans are "right-brained" and thus are not fitted for traditional education which is "left-brained." Poodry lamented such thinking as being a type of "New Age" educational thinking which can possibly hinder the educational success of Native Americans. Poodry, who lives on a reservation of about 1200 people, obviously, feels that Native Americans still have many obstacles to overcome, when it comes to academics, but he feels that they have much to offer the academic and scientific world (Poodry, 2001).

One of the most interesting developments, in Native American education, is the creation of the National Native American Honor Society. Frank Dukepoo was the visionary who started the honor society in 1981. He felt that the society would help promote Native American education, success, and happiness (Dukepoo, 2001). It is obvious that Dukepoo feels that having high expectations is important for academic achievement. According to Dukepoo, at first the Native American honor society only required a 3.0 grade point average (GPA) for entrance. However, one day someone told Dukepoo that unless he lowered the GPA requirement to 2.0, very few Native Americans would make it into the society. At that point, Dukepoo (2001, p. 37) exclaimed angrily, "What an insult to the Hopi people. I never want to hear such negative expectations again. Just for that I am going to move the membership requirement to a 4.0 GPA for at least one semester." Evidently the higher GPA requirement did not hinder growth of the honor society. For, over the course of the years, the membership of the National Native American Honor Society grew from 20, to 100, to 400, to 1000, to over 2000 Native Americans [by 2001] (Dukepoo, 2001). Dukepoo, who was a genetics teacher, also felt that it was important to realize that Native Americans learn like everyone else. He felt that stereotypes about Native Americans having a different "learning style" than other people could hinder Native Americans in academics and in science.

Despite some of the obstacles and barriers Native Americans have faced, there have been some encouraging developments in Western thought; developments which can be embraced by Native Americans, according to Oscar Kawageley (2001). There are some new science theories which should be particularly attractive to Native Americans. In his discussion of some of these new developments, Kawageley mentioned the beautiful new Chaos theories which have gained so much importance, recently, in math and physics. On these new developments in Western thought, he said the following:

> I believe that Western thought is finally moving closer to traditional Native perspectives. The beautiful new mathematics and science of Chaos, for example, include concepts and feelings that approach some of the components of the traditional Yup'ik world-view. In Chaos science and in other topics and approaches, Western science is finally beginning to understand and value the connectedness of the world. There is also some evidence that it is beginning to add feelings to what had been an emotionally barren approach. (Kawageley, 2001, p. 55)

Perhaps Native American Mississippians will also feel attracted to such new developments.

In his book *The Fractal Geometry of Nature*, Benoit Mandelbrot (1983) described a new geometry which, theoretically, could be used to describe such complicated objects as clouds, trees, rock formations, blood vessels systems, and other such complicated phenomenon. The theories are beautiful in that they can provide a sense of order to otherwise chaotic systems. The fractal theories often excite the deepest sense of beauty and wonder among all people—not just Native Americans. Perhaps physics teachers can make use of such theories to excite the interests of Native Americans—while not failing to forget the exhortation that Native Americans learn science in a similar manner as others. Perhaps physics teachers can use chaos theories as an example of how science can proceed in harmony with Native American tradition. According to Gilbert John (2001), who is a scientist himself, young Native Americans can successfully choose a career in science without abandoning their Native American traditions. Gilbert John (2001) asserts, “I know it can be done because I have done it, and I try to convince Indian students that it is also possible for them” (p. 66).

The words of Gilbert John not only have application for Native Americans, but they can be applied to all the cultural groups in Mississippi. African Americans, who were long barred from higher academics, need role models to show them that a career in science is possible. European American Southerners, such as the Scot-Irish, also need positive role models. Contrary to what most people think about European American Southerners, they did not always come from privileged educational, economic, or cultural backgrounds. In fact, Scot-Irish Americans, a group which makes up a large portion of Deep South European Americans, apparently came from a relatively culturally disadvantaged area in Europe. These cultural disadvantages faced by the Scot-Irish did not disappear the instant that the Scot-Irish arrived in the America. In fact, many of these cultural disadvantages can be detected in the Scot-Irish culture, today. And, unless one understands the basic historical background of the Scot-Irish Americans, one cannot fully understand Mississippi or rest of the South. Unless one has a basic understanding of the cultural background of the Scot-Irish Mississippians, one will not be in a good position to offer a solution to the weakness that can be detected in science education in Mississippi.

Scot-Irish Americans in Mississippi

Historically, the Scottish people—like the Irish, British, and Welsh—were considered to be of a slightly different (though closely related) racial stock from the English. The Venerable Bede, famous 8^{th} century historian of England, discussed many of the various ethnic groups of the British Isles in his classic book *Ecclesiastical History of the English People*. Other historians and anthropologists of the past and the present have also discussed the varied cultural groups of the British Isles. For example, in 1885, the anthropologist John Beddoe wrote a comprehensive book titled *The Races of Britain: A Contribution to the Anthropology of Western Europe*. Beddoe's book examined, with great depth, the various physical racial features—such as hair color and eye color—of the people of the British Isles. From his observations one can deduce the existence of different ancient people-groups (some from Iberia, some from the North Germany, some from Scandinavia, etc.) who inhabited or migrated to various regions of the British Isles.

In more recent times, Bryan Sykes (1996) discussed three main ethnic groups of the British Isles—the Saxons, the Vikings, and the Celts—which can still be found in the genetic patterns of Britain and Ireland today. Of course, there are also histories that give more detailed information concerning the particular history of ancient Scotland, such as Alistair Moffat's book *Before Scotland: The Story of Scotland Before History* (2005). The researcher also referenced valuable histories that deal with the particular American immigrant group known as the Scot-Irish, such as Jim Webb's book, *Born Fighting: How* *the Scots-Irish Shaped America* (2004); David Hacket Fischer's book *Albion's Seed: Four British Folkways in America* (1989); or James Leyburn's book *The Scotch Irish: A Social History* (1962).

All of these various histories paint a historical picture of the British Isles which resembles a complicated, twisted knot of intermingled cultures. Nevertheless, this complicated, tangled knot of cultures can be somewhat separated by the diligent researcher into certain discernible strands of cultural and racial groups—or ethnic groups. Since the Scot-Irish Americans of Mississippi were once a part of the kaleidoscope of cultures residing in the British Isles, it was necessary for the researcher to attempt to untangle portions of the complicated cultural history of the British Isles in order to better understand the cultural history of the Scot-Irish.

Over the course of centuries, Scotland evolved along a slightly different historical path than England. Apparently, the Roman Empire, in Britannia, basically stopped at Hadrian's Wall, the border between England and Scotland. Apparently, the Scottish people were not as culturally influenced by Latin forms as were the English. The Scottish—unlike the French, the Spanish, the Italians, the Austrians, and the Germans—were never directly under the influence of the Roman Empire. The Roman Empire, which had spread Greco-Roman civilization and Judeo-Christian civilization throughout Europe, never conquered Scotland.

Roman Catholicism became entrenched in most of the Roman-conquered areas of Europe. Although Roman Catholicism did finally spread to Scotland, it was not as deeply entrenched there as it was in many other places of Europe. Scotland was described, by Leyburn (1962) as being a region that was "on the fringe of

Christendom…untouched by many movements that agitated and disturbed other parts of medieval Europe" (p. 49). Leyburn (1962) went on to say, "At a time when saints were a common feature of the landscape, Scotland had produced no saints; when scholars like Aquinas, Albertus, and Abelard were flourishing abroad, no Scottish scholar appeared" (p. 49). In the years following the Reformation, which officially began with Martin Luther in 1517, Scotland became associated with Protestantism rather than Catholicism. Thus, it was the Protestant forms of the Christian religion which became most common among the Scottish people. A large portion of European American Southerners, especially in the Deep South, are descendents of the people who were originally from the borderlands of Scotland and England (Fischer, 1989). Thus, it would stand to reason that Protestantism has long been strongly represented among the residents of the Deep South.

In comparison to many other groups of Europeans—such as the English, the Germans, the French, the Swiss, or the Italians—the Scots seem to have been relatively unrefined, culturally. Thus, it is only natural that many Southerners would possess many of the same cultural qualities as their forefathers, the Scots. It is, perhaps, more correct to say that the forefathers of most Southerners are the Scot-Irish (rather than just being Scottish), because the group of Scots who moved to Northern Ireland is the group from which most Southerners derive—and this group likely mixed, to some degree, with the native Irish. These Scots who moved to Northern Ireland—and then migrated to the USA in vast numbers—were later given the name Scot-Irish (sometimes possibly to distinguish them from the "regular," Catholic Irish). Leyburn (1962) explains that the name "Scot-Irish" is probably the best name that encompasses all the various facets of this group—the fact that they originally came from Scotland, but later spent some considerable time in Northern Ireland. The Scot-Irish, after the 1600's, evolved (historically speaking) separately from the "regular" Scots; and the Scot-Irish also evolved separately from the so-called Scottish Highlanders, who wear the kilts and play the bagpipes (Leyburn, 1962). Interestingly, according to Leyburn (1962), the Scot-Irish have played a tremendous part of the settling of America and Northern Ireland—and yet, they have often been overlooked and forgotten by history, in many ways. The story of the Scot-Irish begins with King James and the colonization of Northern Ireland.

King James I of England, who began his reign in 1603, was the son of Mary, Queen of Scots; and, not only was he King of England, he was also the King of Scotland (Chodorow, Knox, Schirokauer, Strayer, & Gatzke, 1994). According to Chodorow et al. (1994, p. 482), King James sought the union of England and Scotland. Perhaps his connections to Scotland—such as the fact that his mother was Mary, Queen of Scots—help explain why King James was so favorable to opening up lands in Northern Ireland for the colonization of Scottish people. English people were also encouraged to settle in Northern Ireland (Leyburn, 1962).

With the encouragement of King James, Scottish settlers first began to colonize Northern Ireland in the very early 1600's (Leyburn, 1962). Throughout the 1600's, thousands of Scottish emigrants moved to Northern Ireland. They were instrumental in establishing a foothold of Protestantism in Northern Ireland. Most of these Scottish settlers were poor farmers searching for opportunity, especially for land. Apparently, more Scottish people than English people moved to the newly available lands in Northern Ireland (Leyburn, 1962, pp. 95-96). Perhaps this was due, in part, to the hardness of the Scottish life as described by Leyburn (1962, p. 93). Perhaps the fact that the English were further away from Northern Ireland than were the Scots was a discouraging factor to the English settlers (Leyburn, 1962, p. 93). The poor Scottish farmers received cheap land in return for making the voyage across the Irish Sea to resettle in Northern Ireland.

After living in Northern Ireland for a hundred years or so, the formerly Scottish farmers could have been properly be called “Scot-Irish” instead of just “Scottish.” This term Scot-Irish could have been used to describe them because although they were originally from Scotland, they had established themselves in Ireland—plus, they sometimes mixed with the Irish, as is evidenced by the large number of Irish surnames among the Scot-Irish people (Leyburn, 1962). However, according to Leyburn (1962), the name “Scot-Irish” is not used in Ulster, but the term is used in America.

A hundred years or so after their Scottish ancestors first began settling in Northern Ireland, many of the poor Scot-Irish farmers were again forced, by the pressure of economic and religious circumstances, to make the epic voyage to America. According to Leyburn, poor farming years and “rack-renting” were especially strong factors in the economic pressures that forced them to make the voyage overseas to America. The process of “rack-renting” occurred when landlords in Ireland raised the rents sharply—so that the tenants could no longer afford to stay on the land.

From the early 1700’s onward, thousands upon thousands of these Scot-Irish emigrants crossed the Atlantic Ocean and settled in America (Leyburn, 1962). At first, they mainly settled in Pennsylvania. Then, they fanned out into Virginia and down South through the Carolinas. According to Leyburn (1962), many of the Scot-Irish began sailing directly from Northern Ireland to Charleston, South Carolina. From the Carolinas, the Scot-Irish spread westward and southward. The Scot-Irish formed a significant portion of the population of the Europeans in the South. Perhaps certain cultural weaknesses—academically speaking—of the Scot-Irish can be posited as one of the reasons to explain why the entire South has often lagged behind much of the rest of the nation in matters of science.

Although there exists some literature—albeit a very small amount—which addresses the topic of Southern scientists, there are no research studies, to my knowledge, which thoroughly address the poor physics performance of Southerners in physics. Indeed, the researcher cannot meticulously prove that Southerners have performed more poorly in physics. Yet, it just seems to the researcher that there is largely an absence of prominent Southern physicists (in terms of role models to follow). It seems that there are many famous Southern writers or musicians or athletes. Contrastingly, it seems that the number of famous physicists is extremely small in the South. However, within the scope of this research project, the researcher was unable to meticulously search out and prove that there are less Southern physicists than physicists from other parts of the United States (or Europe). Yet, the lack of role models of famous Southern physicists is highly suggestive that there are very few—and this would imply certain weaknesses, culturally speaking, in their science culture (and science education).

When the researcher was conducting the literature review for this research, it seemed that there was a large gap in the literature concerning the education of "Southern whites," many of whom are of the aforementioned Scot-Irish heritage. There is a large body of evidence that documents the academic disadvantages faced by the African Americans in science; there is some, although not much, literature which documents the academic disadvantages faced by Native Americans in science; there is no literature, to my knowledge, which specifically addresses the academic disadvantages faced by the Scot-Irish people in science.

It is important, for a complete understanding of physics education in Mississippi, that the cultural background of all Mississippians be explored—whether they are of African American, Native American, or Scot-Irish heritage. All of these groups are Mississippians, and are important in science education. It is important to note that there are other cultures, besides these three, which reside in Mississippi. They are all important for a full understanding. Yet, in order to keep the scope of the research from growing too expansive, it was necessary for the researcher to focus the historical portion of the literature review on the three groups that were perceived to have resided in Mississippi for the longest time (in the case of the Native Americans) or in arguably the largest numbers (in the case of the African Americans and the Scot-Irish). The historical portion of the literature review, which largely concerned the three aforementioned cultural groups, may prove useful to the present researcher or to future researchers who wish to correctly interpret research on science education and physics education in Mississippi. It is clear that much research needs to be done to continue helping Mississippi improve its science education and physics education.

APPENDIX B: SOME PAST EFFORTS OF MISSISSIPPIANS TO IMPROVE SCIENCE EDUCATION

Some Organizations, Programs, and University Outreach Programs Developed to Improve Science and Physics Education in Mississippi

Mississippians have made extraordinary efforts, over the years, to improve their level of science education. Indeed, the list of things done by Mississippians to improve science would probably be very long, and the researcher will not—at the present time—be able to make an exhaustive list. However, the researcher will briefly list a few of the organizations and programs that have been formed to help foster a better science program in Mississippi.

First on the list is the Mississippi Academy of Science. Nancy Smith Midgette (1991), who conducted an extensive historical study of the state academies of science throughout the South, said the following about the creation of the Mississippi Academy of Science:

> The Mississippi Academy of Science experienced a long birth process. Chartered in 1930, it did not officially convene for the first time until 1937. One issue of a journal appeared in 1937. One issue of a journal appeared in 1939, but then World War II disrupted both the publication and the annual meetings. Conventions resumed in 1946, but the journal proved more difficult to revive. Only six annual issues appeared irregularly between 1947 and 1960; since then the journal has been published on an annual basis. (p. 67)

Today, the Mississippi Academy of Sciences is much more organized and efficient. One can go to the website of the Mississippi Academy of Sciences and read numerous journal articles (of the *Journal of the Mississippi Academy of Science*) that have been published—on topics ranging from chemistry, to geology, to biology, to physics, to engineering. The number of articles is astounding. Also, on the online website of the Mississippi Academy of Sciences, there is a 72 page history of the Mississippi Academy of Sciences (written by Robert J. Bailey in 1981). The history documents the long, winding road of progress on which Mississippi scientists have travelled since the Mississippi Academy of Science was first formed.

There are many other notable organizations that have been formed to improve Mississippi science. For example—and this is especially relevant to physicists and physics educationalists—there is a society called the Mississippi Association of Physicists. The Mississippi Association of Physicists has a convention each year, often at one of the university campuses. At this convention, many physicists and physics educationalists meet to discuss various issues related to physics. Such a process is beneficial to the professional development of Mississippi physicists. This group could prove instrumental in helping Mississippi to one day acquire adequate preparation for producing world-class physicists.

Another tremendous asset, to Mississippians, is the Rainwater Observatory (in French Camp, Mississippi). Jim Hill, one of the foremost astronomers in Mississippi, helped to direct this observatory for many years. The observatory is one of the largest in the nation, and it is in a nice dark spot of Mississippi—not near many city lights. Thus, it is an excellent resource for Mississippi physicists, astronomers, and any others who are interested in viewing the heavens above. The Rainwater Observatory group, which was led by Mr. Hill in past years, is available for conducting tours (and night sky viewings) at the observatory to groups of students or teachers. Also, the Rainwater Observatory group can conveniently pack some of their telescopes and other educational material into vans and conduct "road shows" at college campuses or other such public places. In the past, Mr. Hill used such events to conduct beautiful computer-animated slide shows which showed the most beautiful and recent pictures available in astronomy. When the weather permitted, he (and other workers with him) often set up portable telescopes for viewings of the heavens. Today, Mr. Edwin Faughn, who produces excellent astronomical artwork, directs the Rainwater Observatory and conducts the "road shows." Indeed, these shows—such as the ones conducted by Mr. Hill and Mr. Faughn—are extraordinarily interesting and informative to future scientists or other curious citizens. The Rainwater Observatory has, in the past, also been available for people who want to stay for summer camps to study astronomy.

An interesting article by Brent M. Jones (2009, 472) discusses "state-supported residential math and science schools." In the early 1980's, Mississippi created the Mississippi School for Mathematics and Science (MSMS) which is on the campus of the Mississippi University for Women, in Columbus, Mississippi. The purpose of MSMS is to choose high-achieving students (based on ACT scores, grades, interviews, etc.) and educate these students for careers in math and science. Hundreds of students attend MSMS; in 1987, the entering class contained 140 students (Jones, 2009, 472). This school provides an excellent opportunity for chosen Mississippians to be educated at the highest level.

Also, in the 1980's, the state of Mississippi created the Mississippi Governor's School. At the MS Governor's School, talented high school students are chosen from throughout the state to attend a summer session which runs approximately three weeks. Students are introduced to a variety of intellectually stimulating subjects—such as philosophy or astrophysics. They can also take other engaging courses such as skin diving or gourmet cooking. While at Governor's School, students have the opportunity to make connections with some of the most talented high school students in Mississippi, connections which could prove beneficial to future developments in Mississippi. Plus, for a few weeks, the students are educated by instructors (many of them college professors) who have the highest level of expertise in their subjects

Mississippi high schools have often participated in Math and Science Competitions. All such competitions foster competition and growth in math and science. Mississippi State has offered many science-related camps, in the past. For example, there is the Rural Medical Scholars program which allows high school students to “shadow” medical doctors. This program allows young Mississippi students to prepare as early as possible to become doctors. Also, Mississippi State University has offered programs for high school girls who are interested in becoming engineers; this is a great program for introducing women to engineering at an early age. Mississippi State University has also, in the past, hosted the Soil Conservation Camps—which fostered a spirit of nature conservation among young students.

Also, the Mississippi Alliance for Minority Participation (MAMP) is another organization that has been designed to help Mississippians advance in the sciences. According to L.G. Hanshaw, "MAMP brought hundreds of thousands of dollars to the University of Mississippi to help improve the participation of minority undergraduate and graduate students in majors for the physical sciences (chemistry, physics, geology, engineering/engineering sciences, etc.) from the 1990's to the present." Such organizations are important for introducing young Mississippians to the career possibilities that exist in the science disciplines, as well as acquainting such students with role models who have succeeded in the sciences.

The University of Mississippi Physics Department offers free physics tutoring to students. There is a tutoring center which is staffed by physics graduate students during many hours of the day. Also, the University of Mississippi Physics Department offers outreach programs to the surrounding community. Every year, around Halloween, the physics department has an "open-house" in which community members can come and see a number of interesting physics demonstrations. Also, the University of Mississippi physics department often has nights where they make several of the telescopes available for public viewing of the night sky. This gives the surrounding community a chance to utilize the instruments of the astronomy department in order to view the heavens.

The University of Mississippi also has a Center for Mathematics and Science Education (CMSE). The CMSE is dedicating to improving math and science education in Mississippi. The CMSE staffs several graduate students, and they often go around to local schools in order to conduct science experiments, judge science fairs, tutor students, hold summer camps, and other such activities related to science and math education. There are many more examples which I could discuss, such as the creation of the Mississippi Museum of Natural Sciences or the many science fairs that are held at high schools around the state. To document all of the efforts of Mississippians to improve science literacy and science education would be a formidable task, and the researcher will not be able document them all or discuss them all. Nevertheless, it is clear that Mississippians have made great efforts to try to improve science education.

In fact, after reviewing the literature concerning what Mississippians have done to try to improve science education in Mississippi, the researcher was astounded by the numerous things that had been done. This part of the literature served to solidify the belief that Mississippians have a great thirst for scientific knowledge and scientific competence. So, whether they are performing well at the highest levels of science or not, Mississippians are definitely trying to improve their knowledge of science.

APPENDIX C: SURVEY FORMS AND QUESTIONNAIRES

Forms for Data Gathering

On the following pages of Appendix C, the complete survey forms and questionnaires are shown. These are the forms that were used during the survey process or the interview process with the students and physicists. Each form shows the title at the top, and these are self-explanatory concerning the purpose of each form. These forms are shown in the following pages of Appendix C.

Mississippi Physics Education: Student Survey Form

This survey form, concerning physics education in Mississippi, will help the researcher gather data for a doctoral thesis at the University of Mississippi (Department of Curriculum and Instruction). This survey will provide important information concerning the topics of Mississippi physics education, American physics education, and global physics education. All participation for this survey is entirely voluntary, and you may skip any question which you do not wish to answer. Thank you for your participation!

Part I: Demographic Information

- Today's Date ______________________
- What is your major? _________________________
- Age ______________
- Gender ______________
- Country you were born in: __________________________
- If you were born in the USA, please list the state you were born in: ___________
- In which state did you obtain most of your high school education? ____________
- Did you take physics at a Mississippi high school? (yes or no)__________

(Optional Question): Please circle your ethnicity from the choices below:
(a) African-American
(b) European-American
(c) Native-American
(d) Latin-American
(e) Asian-American
(f) Indian (from India)
(g) Chinese
(h) Other _________________________________

Part II: Physics Self-Efficacy

(1) Was a physics course offered at your high school?
(a) Yes (b) No (c) I do not know

(2) How many physics courses did you take in high school?
(a) 0 (b) 1 (c) 2 (d) 3 (e) more than 3

(3) Choose one grade that would best be used to describe your high school physics performance?
(a) A (b) B (c) C (d) D (f) F (g) Not Applicable

(4) How many physics courses have you taken in college?
(a) 0 (b) 1 (c) 2 (d) 3 (e) more than 3

(5) Choose one grade that would best be used to describe your college physics performance?
(a) A (b) B (c) C (d) D (f) F (g) Not Applicable

(6) How difficult were your high school physics courses?
(a) Very easy
(b) Easy
(c) Medium Difficulty
(d) Difficult
(e) Very Difficult
(f) Not Applicable, I never have taken a high school physics course

(7) How difficult were your college physics courses?
(a) Very easy
(b) Easy
(c) Medium Difficulty
(d) Difficult
(e) Very Difficult
(f) Not Applicable, I never have taken a college physics course

(8) How good are you at math?
(a) Excellent (b) Above Average (c) Average (d) Below Average (e) Poor

(9) How good are you at physics?
(a) Excellent (b) Above Average (c) Average (d) Below Average (e) Poor

(10) Are people from your ethnicity group good at physics compared to other groups?
(a) Much better (b) Better (c) The Same (d) Worse (e) Much Worse

*(11) Choose which factor is **more** important in order for someone to become a good physicist.*
(a) A person must be born with greater natural mental abilities for physics.
(b) A person must spend many hours in personal study of physics.
(c) They are of the same importance.

(12) Which statement best represents your opinion?
(a) The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.
(b) The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.

(13) Which of the following best represents your beliefs concerning physics performance?
(a) A religious student will usually be better at physics than other students.
(b) A non-religious student will usually be better at physics than other students.
(c) A student who is neither religious nor unreligious will usually be better at physics than other people.
(d) A student's religious views have no effect on whether or not that student will be good at physics.
(e) None of the above.

(14) Are Mississippi students good at physics when compared to students from other countries?
(a) They are generally **much better** in physics than students from other countries.
(b) They are generally **a little better** in physics than students from other countries.
(c) They are generally **the same** in physics as students from other countries.
(d) They are generally **a little worse** in physics than students from other countries.
(e) They are generally **much worse** in physics than students from other countries.

(15) Are American students good in physics when compared to students from other countries?
(a) They are generally **much better** in physics than students from other countries.
(b) They are generally **a little better** in physics than students from other countries.
(c) They are generally **the same** in physics as students from other countries.
(d) They are generally **a little worse** in physics than students from other countries.
(e) They are generally **much worse** in physics than students from other countries.

(16) Choose the answer that best describes your opinion of how physics ability is affected by gender.
(a) Females naturally have better mental ability for physics than males.
(b) Males naturally have better mental ability for physics than females.
(c) Females and males have the same mental ability for physics.

Part III: Short-Answer Questions

(Note: Please write a brief answer below each question that applies to you. If it does not apply to you, leave it blank.)

(17) Do you enjoy the subject of physics? Explain.

(18) Why did you choose **not** *to major in physics? (Note: If this question does not apply to you, please skip this question).*

(19) Why did you choose to major in physics? (Note: If this question does not apply to you, please skip this question.)

(20) Have you chosen a major? If so, why did you choose your particular major?

End of Survey Form

Thank you for your kind participation in this graduate research study!
If you have any questions about the research, you may contact the researcher at the following email address: pdroger1@go.olemiss.edu
You may also contact the researcher via the Department of Curriculum and Instruction at the University of Mississippi.

Qualitative Survey Form: (For Interview with Students)

(Questionnaire for the 10-minute audio-recorded interviews)

Note: *The interviews will be freely conducted so that interesting questions and answers may emerge. However, the questions shown below represent the main body of questions that the researcher plans to ask the each student during the interview.*

(1) Do you think physics is an important subject? Explain

(2) Did you major in physics? Why or why not?

(3) Do you feel that you are well-prepared for your physics class?

(4) What could be done to help students have a better experience with studying physics?

<u>Mississippi Physics Education: Instructor Survey Form</u>

This survey form, concerning physics education in Mississippi, will help the researcher gather data for a doctoral thesis at the University of Mississippi (Department of Curriculum and Instruction). This survey will provide important information concerning the topics of Mississippi physics education, American physics education, and global physics education. All participation for this survey is entirely voluntary, and you may skip any question which you do not wish to answer. Thank you for your participation!

<u>Part I</u>: <u>Demographic Information</u>

- Today's Date ______________________
- Gender ______________
- Country you were born in: __________________________
- If you were born in the USA, please list the state you were born in: ___________

[Note: Due to an error/oversight/correction of the researcher, 8 of the 16 instructor survey forms had a slightly different wording for the above demographic question. The wording was as follows: If you are a US citizen, please list the state you were born in: _________]

- Did you take physics at a Mississippi high school? (yes or no)__________
- In which state (or country) did you obtain most of your high school education?

  ____

(Optional Question): Please circle your ethnicity from the choices below:
(a) African-American
(b) European-American
(c) Native-American
(d) Latin-American
(e) Asian-American
(f) Indian (from India)
(g) Chinese
(h) Other _________________________________

<u>Part II</u>: Physics Self-Efficacy

(1) Was a physics course offered at your high school?
(a) Yes (b) No (c) I do not know

(2) During what time period of your life did you begin to develop an interest in physics?
(a) before the age of 12
(b) between the ages of 12 and 15
(c) between the ages of 15 and 18
(d) between the ages of 18 and 21
(e) after age 21

(3) During what time period of your life did you begin to conduct serious academic work towards increasing your skill in physics?
(a) before the age of 12
(b) between the ages of 12 and 15
(c) between the ages of 15 and 18
(d) between the ages of 18 and 21
(e) after age 21

*(4) Choose which factor is **more** important in order for someone to become a good physicist.*
(a) A person must be born with greater natural mental abilities for physics.
(b) A person must spend many hours in personal study of physics.
(c) They are of the same importance.

(5) Which statement best represents your opinion?
(a) The majority of people are born with the necessary mental capacity to become physicists when they reach adulthood.
(b) The majority of people are **not** born with the necessary mental capacity to become physicists when they reach adulthood.

(6) Which of the following best represents your beliefs concerning physics?
(a) A religious student will usually be better at physics than other students.
(b) A non-religious student will usually be better at physics than other students.
(c) A student who is neither religious nor unreligious will usually be better at physics than other people.
(d) A student's religious views have no effect on whether or not that student will be good at physics.
(e) None of the above.

(7) Are Mississippi students good at physics when compared to students from other countries?

(a) They are generally **much better** in physics than students from other countries.
(b) They are generally **a little better** in physics than students from other countries.
(c) They are generally **the same** in physics as students from other countries.
(d) They are generally **a little worse** in physics than students from other countries.
(e) They are generally **much worse** in physics than students from other countries.

(8) Are American students good in physics when compared to students from other countries?

(a) They are generally **much better** in physics than students from other countries.
(b) They are generally **a little better** in physics than students from other countries.
(c) They are generally **the same** in physics as students from other countries.
(d) They are generally **a little worse** in physics than students from other countries.
(e) They are generally **much worse** in physics than students from other countries.

(9) Choose the answer that best describes your opinion of how physics ability is affected by gender.

(a) Females naturally have better mental ability for physics than males.
(b) Males naturally have better mental ability for physics than females.
(c) Females and males have the same mental ability for physics.

Part III: Short-Answer Questions

(Note: Please write a brief answer below each question that applies to you. If it does not apply to you, leave it blank.)

(10) Why did you choose to pursue a career in physics?

(11) Would you recommend a career in physics to students who are in the process of choosing a major?

(12) In your opinion, what can be done to improve physics education in Mississippi so that students are better prepared for the rigors of physics?

End of Survey Form

Thank you for your kind participation in this graduate research study!
If you have any questions about the research, you may contact the researcher at the following email address: pdroger1@go.olemiss.edu
You may also contact the researcher via the Department of Curriculum and Instruction at the University of Mississippi.

Qualitative Survey Form (Interview with Physics Instructors)

(Questionnaire for the 10-minute audio-recorded interviews)

Note: The interviews will be freely conducted so that interesting questions and answers may emerge. However, the questions shown below represent the main body of questions that the researcher plans to ask the each instructor during the interview.

(1) In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places?

(2) In general, how do American students compare with international students, in your opinion? If there is a difference, what are the reasons for these differences?

(3) Do economic factors play a large part in students choosing to pursue (or not to pursue) graduate studies in physics? Do these factors differ significantly from country to country?

(4) What could be done to make the Mississippi education system better for producing highly skilled science and math students?

(5) When did you become interested in physics? Did you take physics in high school?

(6) What were the important factors that allowed you to be successful in physics?

(7) Does the physics profession represent a profession in which Mississippi students can realistically obtain a well-paying job with satisfying job conditions?

<u>Qualitative Survey Form (Interview with Successful Mississippi Physicists)</u>

(Questionnaire for the 10-minute audio-recorded interviews)

<u>Note</u>*: The interviews will be freely conducted so that interesting questions and answers may emerge. However, the questions shown below represent the main body of questions that the researcher plans to ask the each instructor during the interview.*

(1) Why did you choose to pursue a career in physics?

(2) What obstacles did you have to overcome during your years as a student and during your years as a physicist?

(3) Do you think that Mississippi students are as well prepared, as other students, for the academic rigors of physics?

(4) Do economic factors play a large part in students choosing to pursue (or not to pursue) graduate studies in physics?

(5) What were the key factors, in your opinion, to your success in physics?

(6) What could be done to make the Mississippi education system better for producing physics students who will be in a position to have a successful career in physics?

APPENDIX D: QUANTITATIVE GRADUATE SCHOOL STATISTICS, QUANTITATIVE SURVEY RESULTS, AND WRITTEN SURVEY RESPONSES (WITH THEME TABLES)

General Overview

In the following pages, the descriptive statistics obtained from various U.S. university graduate schools (for physics) and from various University of Mississippi graduate degree programs (including physics) are shown in Table 1-Table 30. Following that section, the demographic statistics and the survey results (for each survey question) are shown in tables. The survey answers and descriptive statistics were tabulated for several different sample groups. Pertinent demographic information is also shown for each sample group. Also, in this chapter are included the students' and the physicists' written responses to the short-answer survey questions. After the written responses, theme tables are included. These show the categorization of the responses into themes.

Descriptive Statistics of Eight Graduate Degree Programs at the University of Mississippi (Fall Semester 2003-Full Summer Semester 2012)

The following thirty tables (Table 1-Table 30) contain the descriptive statistics of data from the graduate schools of several U.S. universities. Also shown are the descriptive statistics from several graduate degree programs at the University of Mississippi. The tables show the number and percent of graduate degrees that were awarded to in-state students by that particular university graduate degree program.

Table 1

Data from University of Mississippi for Fall 2003-Summer 2012 (Master of Science Degree in Chemistry)

Academic Year	# of Chemistry M.S. degrees awarded	# of Chemistry M.S. degrees awarded (MS residents)	% MS residents
2003-2004	2	0	0.0 %
2004-2005	0	0	NA
2005-2006	2	1	50.0 %
2006-2007	3	2	66.7 %
2007-2008	3	1	33.3 %
2008-2009	1	0	0.0 %
2009-2010	2	1	50.0 %
2010-2011	3	2	66.7 %
2011-2012	2	1	50.0 %
TOTAL	18	8	44.4 %

Note. For these tables for the graduate degree recipients at the University of Mississippi, the "Academic Year" can be understood to start with the Fall semester (which generally starts around the latter part of August) and continue up through the end of the Full Summer semester (generally near the end of July) of the next year. Thus, for example, the Academic Year 2003-2004, would start at the beginning of the Fall semester of 2003 (starting around the latter part of August 2003) and would continue up through the end of the Full Summer semester of 2004 (ending near the end of July 2004).

Table 2

Data from University of Mississippi for Fall 2003-Summer 2012 (PhD Degree in Chemistry)

Academic Year	# of Chemistry PhD degrees awarded	# of Chemistry PhD degrees awarded (MS residents)	% MS residents
2003-2004	2	1	50.0 %
2004-2005	0	0	NA
2005-2006	3	1	33.3 %
2006-2007	4	0	0.0 %
2007-2008	2	0	0.0 %
2008-2009	1	0	0.0 %
2009-2010	4	0	0.0 %
2010-2011	4	1	25.0 %
2011-2012	5	3	60.0 %
TOTAL	25	6	24.0 %

Note. During the Academic Year 2006-2007, one student (who was a Mississippi resident) was awarded a Doctor of Arts in Chemistry (in other words, a DA in Chemistry); the researcher (P. Rogers) did not include this particular student's data in above table. Also, during the Academic Year 2007-2008, one student (who was a Mississippi resident) was awarded a Doctor of Arts in Chemistry; the researcher did not include this particular student's data within the above table. Lastly, during the Academic Year 2008-2009, one student (who was a Mississippi resident) was awarded a Doctor of Arts in Chemistry; the researcher did not include this particular student's data within the above table, either. The researcher did not include these three students' data in the table above, because their doctoral degree type was not exactly the same as the degree type listed in the table above.

Table 3

Data from University of Mississippi for Fall 2003-Summer 2012 (Master of Business Administration Degree)

Academic Year	# of MBA Degrees Awarded	# of MBA Degrees Awarded (MS Residents)	% MS Residents
2003-2004	83	51	61.4 %
2004-2005	52	33	63.5 %
2005-2006	34	21	61.8 %
2006-2007	41	20	48.8 %
2007-2008	30	18	60.0 %
2008-2009	47	32	68.1 %
2009-2010	58	43	74.1 %
2010-2011	55	35	63.6 %
2011-2012	80	46	57.5 %
TOTAL	480	299	62.3 %

Table 4

Data from University of Mississippi for Fall 2003-Summer 2012 (PhD Degree in Business Administration)

Academic Year	# of Business Administration PhD Degrees Awarded	# of Business Administration PhD Degrees Awarded (MS Residents)	% MS Residents
2003-2004	4	2	50.0 %
2004-2005	16	7	43.8 %
2005-2006	12	4	33.3 %
2006-2007	10	3	30.0 %
2007-2008	9	2	22.2 %
2008-2009	6	2	33.3 %
2009-2010	5	2	40.0 %
2010-2011	8	4	50.0 %
2011-2012	6	1	16.7 %
TOTAL	76	27	35.5 %

Table 5

Data from University of Mississippi for Fall 2003-Summer 2012 (Master of Accountancy Degree)

Academic Year	# of Master of Accountancy (M Accy) Degrees Awarded	# of Master of Accountancy (M Accy) Degrees Awarded (MS Residents)	% MS Residents
2003-2004	49	36	73.5 %
2004-2005	41	31	75.6 %
2005-2006	46	42	91.3 %
2006-2007	51	35	68.6 %
2007-2008	48	40	83.3 %
2008-2009	53	37	69.8 %
2009-2010	74	55	74.3 %
2010-2011	75	57	76.0 %
2011-2012	73	50	68.5 %
TOTAL	510	383	75.1 %

Table 6

Data from University of Mississippi for Fall 2003-Summer 2012 (PhD Degree in Accountancy)

Academic Year	# of Accountancy PhD Degrees Awarded	# of Accountancy PhD Degrees Awarded (MS Residents)	% MS Residents
2003-2004	2	2	100.0 %
2004-2005	1	0	0.0 %
2005-2006	5	2	40.0 %
2006-2007	0	0	NA
2007-2008	3	1	33.3 %
2008-2009	2	2	100.0 %
2009-2010	1	0	0.0 %
2010-2011	2	2	100.0 %
2011-2012	5	3	60.0 %
TOTAL	21	12	57.1 %

Table 7

Data from University of Mississippi for Fall 2003-Summer 2012 (Master of Science Degree in Engineering Science)

Academic Year	# of Engineering Science M.S. Degrees Awarded	# of Engineering Science M.S. Degrees Awarded (MS Residents)	% MS Residents
2003-2004	56	21	37.5 %
2004-2005	53	15	28.3 %
2005-2006	54	18	33.3 %
2006-2007	38	11	28.9 %
2007-2008	46	15	32.6 %
2008-2009	35	14	40.0 %
2009-2010	31	10	32.3 %
2010-2011	42	18	42.9 %
2011-2012	33	13	39.4 %
TOTAL	388	135	34.8 %

Note. During the Academic Year 2007-2008, one of the master's degrees was listed as "MS Engr SciA" rather than just "MS Engr Sci" like all the others. This particular student was listed as a Mississippi resident. The researcher (P. Rogers) did include this data in the statistics as one of the 15 Mississippi resident "MS. Engr Sci" degrees for the Academic Year 2007-2008 in the table above. The researcher made the assumption that the extra letter shown in this one student's particular degree listing was an anomalous typographical error, because the "MS Engr SciA" degree was not found in the degree abbreviation key which the researcher had access to. However, the "MS Engr Sci" degree was found in the degree abbreviation key.

Table 8

Data from University of Mississippi for Fall 2003-Summer 2012 (PhD Degree in Engineering Science)

Academic Year	# of Engineering Science PhD Degrees Awarded	# of Engineering Science PhD Degrees Awarded (MS Residents)	% MS Residents
2003-2004	6	1	16.7 %
2004-2005	5	1	20.0 %
2005-2006	8	1	12.5 %
2006-2007	14	1	7.1 %
2007-2008	9	2	22.2 %
2008-2009	13	0	0.0 %
2009-2010	12	1	8.3 %
2010-2011	11	2	18.2 %
2011-2012	6	1	16.7 %
TOTAL	84	10	11.9 %

Table 9

Data from University of Mississippi for Fall 2003-Summer 2012 (Master of Arts Degree in History)

Academic Year	# of History M.A. Degrees Awarded	# of History M.A. Degrees Awarded (MS Residents)	% MS Residents
2003-2004	10	5	50.0 %
2004-2005	14	9	64.3 %
2005-2006	5	3	60.0 %
2006-2007	6	5	83.3 %
2007-2008	6	4	66.7 %
2008-2009	4	3	75.0 %
2009-2010	4	2	50.0 %
2010-2011	12	7	58.3 %
2011-2012	8	3	37.5 %
TOTAL	69	41	59.4 %

Table 10

Data from University of Mississippi for Fall 2003-Summer 2012 (PhD Degree in History)

Academic Year	# of History PhD Degrees Awarded	# of History PhD Degrees Awarded (MS Residents)	% MS Residents
2003-2004	4	3	75.0 %
2004-2005	6	3	50.0 %
2005-2006	6	3	50.0 %
2006-2007	2	1	50.0 %
2007-2008	4	2	50.0 %
2008-2009	4	2	50.0 %
2009-2010	7	3	42.9 %
2010-2011	2	0	0.0 %
2011-2012	7	4	57.1 %
TOTAL	42	21	50.0 %

Table 11

Data from University of Mississippi for Fall 2003-Summer 2012 (Master of Arts Degree in English)

Academic Year	# of English M.A. Degrees Awarded	# of English M.A. Degrees Awarded (MS Residents)	% MS Residents
2003-2004	13	7	53.8 %
2004-2005	7	1	14.3 %
2005-2006	5	2	40.0 %
2006-2007	5	1	20.0 %
2007-2008	7	3	42.9 %
2008-2009	4	3	75.0 %
2009-2010	4	3	75.0 %
2010-2011	1	0	0.0 %
2011-2012	11	6	54.5 %
TOTAL	57	26	45.6 %

Table 12

Data from University of Mississippi for Fall 2003-Summer 2012 (PhD Degree in English)

Academic Year	# of English PhD Degrees Awarded	# of English PhD Degrees Awarded (MS Residents)	% MS Residents
2003-2004	7	6	85.7 %
2004-2005	2	0	0.0 %
2005-2006	6	2	33.3 %
2006-2007	3	1	33.3 %
2007-2008	6	5	83.3 %
2008-2009	14	7	50.0 %
2009-2010	6	1	16.7 %
2010-2011	7	2	28.6 %
2011-2012	1	0	0.0 %
TOTAL	52	24	46.2 %

Table 13

Data from University of Mississippi for Fall 2003-Summer 2012 (Master of Science Degree in Mathematics)

Academic Year	# of Mathematics M.S. Degrees Awarded	# of Mathematics M.S. Degrees Awarded (MS Residents)	% MS Residents
2003-2004	8	6	75.0 %
2004-2005	5	3	60.0 %
2005-2006	6	3	50.0 %
2006-2007	9	4	44.4 %
2007-2008	6	3	50.0 %
2008-2009	6	4	66.7 %
2009-2010	5	5	100.0 %
2010-2011	11	5	45.5 %
2011-2012	4	3	75.0 %
TOTAL	60	36	60.0 %

Note. During the Academic Year 2007-2008, one student (who was a Mississippi resident) was awarded a Master of Arts degree in Mathematics (in other words, an M.A. degree in Math); also, during the Academic Year 2009-2010, another student (who was also a Mississippi resident) was awarded a Master of Arts degree in Mathematics. The researcher (P. Rogers) did not include the data for these two students within the table above, because their master's degree type was not exactly the same as the master's degree type listed in the table above.

Table 14

Data from University of Mississippi for Fall 2003-Summer 2012 (PhD Degree in Mathematics)

Academic Year	# of Mathematics PhD Degrees Awarded	# of Mathematics PhD Degrees Awarded (MS Residents)	% MS Residents
2003-2004	1	1	100.0 %
2004-2005	4	3	75.0 %
2005-2006	9	4	44.4 %
2006-2007	4	2	50.0 %
2007-2008	2	1	50.0 %
2008-2009	5	2	40.0 %
2009-2010	1	0	0.0 %
2010-2011	3	1	33.3 %
2011-2012	1	1	100.0 %
TOTAL	30	15	50.0 %

Table 15

Data from University of Mississippi for Fall 2003-Summer 2012 (Master of Arts Degree in Physics)

Academic Year	# of Physics M.A. Degrees Awarded	# of Physics M.A. Degrees Awarded (MS Residents)	% MS Residents
2003-2004	1	1	100.0 %
2004-2005	1	0	0.0 %
2005-2006	0	0	NA
2006-2007	4	2	50.0 %
2007-2008	3	0	0.0 %
2008-2009	3	1	33.3 %
2009-2010	2	1	50.0 %
2010-2011	0	0	NA
2011-2012	2	0	0.0 %
TOTAL	16	5	31.3 %

Table 16

Data from University of Mississippi for Fall 2003-Summer 2012 (Master of Science Degree in Physics)

Academic Year	# of Physics M.S. Degrees Awarded	# of Physics M.S. Degrees Awarded (MS Residents)	% MS Residents
2003-2004	2	1	50.0 %
2004-2005	2	0	0.0 %
2005-2006	1	1	100.0 %
2006-2007	3	2	66.7 %
2007-2008	1	0	0.0 %
2008-2009	1	1	100.0 %
2009-2010	3	0	0.0 %
2010-2011	0	0	NA
2011-2012	6	5	83.3 %
TOTAL	19	10	52.6 %

Table 17

Data from University of Mississippi for Fall 2003-Summer 2012 (PhD Degree in Physics)

Academic Year	# of Physics PhD Degrees Awarded	# of Physics PhD Degrees Awarded (MS Residents)	% MS Residents
2003-2004	2	2	100.0 %
2004-2005	0	0	NA
2005-2006	1	0	0.0 %
2006-2007	2	1	50.0 %
2007-2008	2	2	100.0 %
2008-2009	4	1	25.0 %
2009-2010	3	0	0.0 %
2010-2011	1	1	100.0 %
2011-2012	3	0	0.0 %
TOTAL	18	7	38.9 %

Table 18

Data from University of Arkansas for 2002-2012 (Master of Arts Degree in Physics)

Year[a]	# of Physics M.A. Degrees Awarded	From Arkansas	% From Arkansas
2002	1	0	0 %
2003	4	3	75.0%
2004	4	3	75.0%
2005	0	0	0%
2006	1	0	0%
2007	4	3	75.0%
2008	4	3	75.0%
2009	1	1	100%
2010	0	0	NA
2011	0	0	NA
2012	0	0	NA
TOTAL	19	13	68.4%

Note. The numerical data for the above table (and the following two tables) from the University of Arkansas was condensed and provided by Ms. Marilyn Wilson and others in her office at the Office of Institutional Research at the University of Arkansas. Ms. Wilson said the data was arranged in such a way as has to be reported to IPEDS. She obtained the data from the website oir.uark.edu/home/
[a]Concerning how the years are represented in the above table (and the following two tables from Univ. of Arkansas), the researcher (P. Rogers) was referred (by Ms. Wilson) to Mr. Ciprian Caloianu, Project Program Specialist at the University of Arkansas. Mr. Caloianu said the years can be understood as covering the following time frame: Year 2002, in the above table (and the following two tables), would represent the time frame between July 2001-July 2002.

Table 19

Data from University of Arkansas for 2002-2012 (Master of Science Degree in Physics)

Year	# of Physics M.S. Degrees Awarded	From Arkansas	% From Arkansas
2002	2	0	0%
2003	2	0	0%
2004	6	1	16.7%
2005	5	2	40.0%
2006	4	2	50.0%
2007	5	0	0%
2008	4	1	25.0%
2009	5	3	60.0%
2010	6	0	0%
2011	3	2	66.7%
2012	3	0	0%
TOTAL	45	11	24.4%

Table 20

Data from University of Arkansas for 2002-2012 (PhD Degree in Physics)

Year	# of Physics PhD Degrees Awarded	From Arkansas	% From Arkansas
2002	3	0	0%
2003	3	0	0%
2004	4	1	25.0%
2005	5	0	0%
2006	6	1	16.7%
2007	1	0	0%
2008	3	1	33.3%
2009	0	0	0%
2010	3	0	0%
2011	3	0	0%
2012	1	0	0%
TOTAL	32	3	9.4%

Table 21

Data from University of Minnesota, Duluth for July 2002-June 2012 (Master of Science Degree in Physics)

Year	# of Physics M.S. Degrees Awarded	# of Physics M.S. Degrees Awarded (MN Resident)	% MN Residents
2002-2003	1	0	0 %
2003-2004	3	0	0 %
2004-2005	2	1	50.0 %
2005-2006	1	0	0 %
2006-2007	1	1	100 %
2007-2008	3	1	33.3 %
2008-2009	2	1	50.0 %
2009-2010	3	1	33.3 %
2010-2011	6	0	0 %
2011-2012	3	1	33.3 %
TOTAL	25	6	24.0 %

Note. The above table (and the two following tables), from University of Minnesota, were obtained from information sent to me by Mr. Brad Bostrom, Director at the office of Systems & Data Management at the Graduate School of the University of Minnesota. The researcher (P. Rogers) was referred to Mr. Bostrom by another official from the graduate school of the University of Minnesota. Mr. Bostrom stated (via email communication), that the time frame for each year shown in the table extends from July through June. The researcher (P. Rogers) assumes that this means that the Year 2002-2003 in the table would extend from July 2002 through June 2003; then, the next year (Year 2003-2004) would extend from July 2003 up through June 2004; and so on. Mr. Bostrom also stated that the residence status of the students in the above table (and the two following tables) was obtained from their applications for admission [into the graduate school].

Table 22

Data from University of Minnesota, Twin Cities for July 2002-June 2012 (Master of Science Degree in Physics)

Year	# of Physics M.S. Degrees Awarded	# of Physics M.S. Degrees Awarded (MN Residents)	% MN Residents
2002-2003	7	2	28.6 %
2003-2004	3	1	33.3 %
2004-2005	7	3	42.9 %
2005-2006	5	0	0 %
2006-2007	9	2	22.2 %
2007-2008	7	1	14.3 %
2008-2009	3	1	33.3 %
2009-2010	4	1	25.0 %
2010-2011	8	4	50.0 %
2011-2012	6	2	33.3 %
TOTAL	59	17	28.8 %

Table 23

Data from University of Minnesota, Twin Cities for July 2002-June 2012 (PhD Degree in Physics)

Year	# of Physics PhD Degrees Awarded	# of Physics PhD Degrees Awarded (MN Residents)	% MN Residents
2002-2003	20	6	30.0 %
2003-2004	13	4	30.8 %
2004-2005	11	0	0 %
2005-2006	16	7	43.8 %
2006-2007	17	2	11.8 %
2007-2008	22	2	9.1 %
2008-2009	11	3	27.3 %
2009-2010	19	4	21.1 %
2010-2011	17	9	52.9 %
2011-2012	13	2	15.4 %
TOTAL	159	39	24.5 %

Table 24

Data from University of Alabama for June 2002-May 2013 (Master of Science Degree in Physics)

Year[a]	# of Physics M.S. Degrees Awarded	# of Physics M.S. Degrees Awarded (AL Resident)	% AL Residents
2002-2003	5	0	0 %
2003-2004	4	0	0 %
2004-2005	2	0	0 %
2005-2006	2	1	50.0 %
2006-2007	8	2	25.0 %
2007-2008	6	2	33.3 %
2008-2009	5	1	20.0 %
2009-2010	8	2	25.0 %
2010-2011	4	0	0 %
2011-2012	7	3	42.9 %
2012-2013	4	2	50.0 %
TOTAL	55	13	23.6 %

Note. The data for the table above (and the following table), concerning the University of Alabama, was provided to me by Ms. Cathy Andreen, Director of Media Relations at the University of Alabama (as of Summer 2013 when the data was obtained). Concerning how the residence status of the students was determined for the data, Ms. Andreen said, "We pulled the state/country of residence on record at the beginning of their last term before graduating (basically, where they sat while earning their last credits before graduating)."

[a]In the original data which was provided by Ms. Andreen, each year in the data table was listed in terms of single years such as 2003, 2004, 2005, and so on up to 2013. Ms. Andreen said that the years which were listed were "degree years". According to Ms. Andreen, the "degree year 2003 would equate to 2002-03 which includes the August 2002, December 2002, and May 2003 commencements." So, having that information allowed the researcher (P. Rogers) to replace the old label "2003" with a new label "2002-2003"; and, the researcher (P. Rogers) did the same for the other years up to the last year, "2013" which was re-labeled as "2012-2013". It is implied by the information which was provided by Ms. Andreen that the Year 2002-2003 covers the time period from June 2002-May 2003; the Year 2003-2004 runs from June 2003 to May 2004; and so on for the other academic years.

Table 25

Data from University of Alabama for June 2002-May 2013 (PhD Degree in Physics)

Year[a]	# of Physics PhD Degrees Awarded	# of Physics PhD Degrees Awarded (AL Residents)	% AL Residents
2002-2003	2	0	0 %
2003-2004	7	0	0 %
2004-2005	5	1	20.0 %
2005-2006	5	0	0 %
2006-2007	3	0	0 %
2007-2008	7	2	28.6 %
2008-2009	5	0	0 %
2009-2010	5	1	20.0 %
2010-2011	4	0	0 %
2011-2012	5	0	0 %
2012-2013	2	0	0 %
TOTAL	50	4	8.0 %

[a]In the original data which was provided by Ms. Cathy Andreen, Director of Media Relations at the University of Alabama (as of Summer 2013 when the data was obtained), each year in the data table was listed in terms of single years such as 2003, 2004, 2005, and so on up to 2013. Ms. Andreen said that the years which were listed were "degree years". According to Ms. Andreen, the "degree year 2003 would equate to 2002-03 which includes the August 2002, December 2002, and May 2003 commencements." So, having that information allowed the researcher (P. Rogers) to replace the old label "2003" with a new label "2002-2003"; and, the researcher (P. Rogers) did the same for the other years up to the last year, "2013" which was re-labeled as "2012-2013". It is implied by the information which was provided by Ms. Andreen that the Year 2002-2003 covers the time period from June 2002-May 2003; the Year 2003-2004 runs from June 2003 to May 2004; and so on for the other academic years.

Table 26

Data from Louisiana State University for Summer 2003-Spring 2012 (Master Degree in Physics)

Year	# of Physics Master Degrees Awarded[a]	# of Physics Master Degrees Awarded (LA Resident)	% LA Residents
2003-2004	4	1	25.0 %
2004-2005	7	2	28.6 %
2005-2006	3	2	66.7 %
2006-2007	8	4	50.0 %
2007-2008	12	2	16.7 %
2008-2009	12	5	41.7 %
2009-2010	10	1	10.0 %
2010-2011	6	1	16.7 %
2011-2012	9	3	33.3 %
TOTAL	71	21	29.6 %

Note. The data table above (and the following data table) from Louisiana State University, were obtained from information sent to the researcher (P. Rogers) in the summer of 2013 by Mr. Bernie Braun of the Office of Budget and Planning at Louisiana State University. Mr. Braun was assisted by Ms. Rami LeBlanc who was also a staff member in the Office of Budget and Planning at the time the researcher (P. Rogers) obtained the data. According to Mr. Braun, the time span for each year of the data "includes summer, then fall, ending with spring. For example, 2003-2004 would be Summer 2003, Fall 2003, and Spring 2004 graduates." When asked for more detailed information on how the residence status of the students was determined, Mr. Braun provided the following statement: "Upon applying to LSU, the student provides a permanent home address. This can be updated at any time in the student's academic career by the student. The address on file at the time of graduation is the one used in the reports on our web site and [on the] report I created for you."
[a]According to Mr. Bernie Braun of the Office of Budget and Planning at Louisiana State University, the data for the Master's degree actually contains the data for two degrees (M.S. in Physics and the degree in Medical/Health Physics).

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Table 27

Data from Louisiana State University for Summer 2003-Spring 2012 (Doctoral Degree in Physics)

Year	# of Physics Doctoral Degrees Awarded	# of Physics Doctoral Degrees Awarded (LA Resident)	% LA Residents
2003-2004	8	4	50.0 %
2004-2005	1	0	0 %
2005-2006	5	1	20.0 %
2006-2007	5	0	0 %
2007-2008	4	1	25.0 %
2008-2009	9	0	0 %
2009-2010	8	2	25.0 %
2010-2011	13	3	23.1 %
2011-2012	8	1	12.5 %
TOTAL	61	12	19.7 %

Table 28

Data from University of Virginia for 2003-2012 (Master of Arts Degree in Physics)

Year	# of Physics M.A. Degrees Awarded	# of Physics M.A. Degrees Awarded (VA Residents)[a]	% VA Residents
2003	7	2	28.6 %
2004	3	0	0 %
2005	3	0	0 %
2006	1	1	100.0 %
2007	6	2	33.3 %
2008	0	0	0 %
2009	8	1	12.5 %
2010	5	3	60.0 %
2011	6	2	33.3 %
2012	2	0	0 %
TOTAL	41	11	26.8 %

Note. When the original data for the above table (and the two following tables), concerning the University of Virginia, was provided to the researcher (P. Rogers) in the summer of 2013, the data for each "Completion Term" for each degree was labeled as follows: 2003 Fall, 2003 Spring, 2003 Summer, 2004 Fall, 2004 Spring, 2004 Summer, 2005 Fall, 2005 Spring, 2005 Summer, and so on up though 2012 (and also including partial data for 2013). The researcher (P. Rogers) was unsure as to how to arrange and classify the data properly. For example, when presented with data for 2003 Fall, 2003 Spring, 2003 Summer, the researcher was unsure if all of these data sets were for the actual calendar year 2003 or if they were listed in terms of some type of semester code for the academic year 2002-2003. It seemed possible that the 2003 Fall data might actually coincide with the fall of 2002 (calendar year) rather than the fall of 2003 (calendar year). It was unclear to the researcher (P. Rogers) from the data he received. Since the researcher (P. Rogers) was mainly interested in making a rough comparison between yearly increments, he decided to put the data into the above table (and the two following tables) in such a way that Year 2003 goes with the data he was given for 2003 Fall, 2003 Spring, and 2003 Summer. This assumes that the 2003 Fall data coincides with the fall semester of the calendar year 2003; this assumes that the 2003 Spring data coincides with the spring semester of the calendar year 2003; and this assumes that the 2003 Summer data coincides with the summer semester of the calendar year 2003. The researcher (P. Rogers) made the same assumption when he classified the other data sets into each respective Year shown in the above table and the two following tables (concerning the University of Virginia). Thus, the data in the above table (and the two following tables) for Year 2004 comes from the data the researcher (P. Rogers) received for 2004 Fall, 2004 Spring, and 2004 Summer. The data for Year 2005 comes from the data the researcher (P. Rogers) received for 2005 Fall, 2005 Spring, and 2005 Summer. And, the researcher used the same method of classification for each year up through 2012 in the above table (and the two following tables) for the University of Virginia. In this way, each year still should represent a year's time span of data, and so one should still get a good rough comparison with the other universities' data. The researcher (P. Rogers) did not include the data for 2013 since only the 2013 Spring data was provided. This is reasonable since the researcher (P. Rogers) was provided with the data in the summer of 2013.

[a]As far as the researcher is aware, "VA Residents" in this data table (and Table 29 and Table 30 which follow) means only those students who listed Virginia as the state of their permanent home address; the researcher assumes that this would not include anyone who might have established in-state residency (but did not list Virginia as the state of their permanent home address). The researcher makes these assumptions based on statements mentioned by Ms. Tracy Mourton (see note below Table 30), and on the way the data was arranged so that the "Home Address State" was the category that was provided in the data concerning the information about which U.S. state the student was from. The researcher used the "Home Address State" to determine the state of the student's residency for the above table.

Table 29

Data from University of Virginia for 2003-2012 (Master of Science Degree in Physics)

Year	# of Physics M.S. Degrees Awarded	# of Physics M.S. Degrees Awarded (VA Residents)[a]	% VA Residents
2003	1	0	0 %
2004	3	2	66.7 %
2005	3	1	33.3 %
2006	3	3	100 %
2007	0	0	0 %
2008	3	2	66.7 %
2009	0	0	0 %
2010	2	0	0 %
2011	2	1	50.0 %
2012	1	1	100 %
TOTAL	18	10	55.6 %

[a]As far as the researcher is aware, "VA Residents" in this data table (and in Table 28 and Table 30) means only those students who listed Virginia as the state of their permanent home address (see full note below Table 30).

Table 30

Data from University of Virginia for 2003-2012 (PhD Degree in Physics)

Year	# of Physics PhD Degrees Awarded	# of Physics PhD Degrees Awarded (VA Residents)[a]	% VA Residents
2003	9	6	66.7 %
2004	7	4	57.1 %
2005	9	3	33.3 %
2006	11	5	45.5 %
2007	13	8	61.5 %
2008	9	3	33.3 %
2009	8	3	37.5 %
2010	17	7	41.2 %
2011[b]	10	6	60.0 %
2012	12	1	8.3 %
TOTAL	105	46	43.8 %

Note. The data for the above three tables, concerning the University of Virginia, was provided to the researcher (P. Rogers) in the summer of 2013 by Ms. Tracy Mourton, GSAS Registrar at the University of Virginia. Briana Reid, Admissions Specialist at the Graduate School of Arts and Sciences at the University of Virginia, also assisted the researcher (P. Rogers) with this data request in the summer of 2013. When asked for further details about how the residence statuses were determined, Ms. Mourton stated: "Home state is determined by the permanent home address used on the graduate application. Every student (even in-state) must petition to receive in-state tuition so residency is established and maintained throughout the course of the student's graduate career. In order to be considered in-state, a student must have lived in VA for one year while working and paying taxes."

[a]As far as the researcher is aware, "VA Residents" in this data table (and in Table 28 and Table 29) means only those students who listed Virginia as the state of their permanent home address; the researcher assumes that this would not include anyone who might have established in-state residency (but did not list Virginia as the state of their permanent home address). The researcher makes these assumptions based on statements mentioned by Ms. Tracy Mourton (in the above note), and on the way the data was arranged so that the "Home Address State" was the category that was provided in the data concerning the information about which U.S. state the student was from. The researcher used the "Home Address State" to determine the state of the student's residency for the above table.

[b]For the Year 2011 (in the above data table for PhD degrees), there were two students who had "home address" classifications that were ambiguous or unlisted. More specifically, one of the students had Virginia listed as the "Home Address State," but a foreign country listed as the "Home Address Country

[Description].” The other student in question had no “Home Address State” or “Home Address Country [Description]” listings at all. This introduced uncertainty as to how these two students’ residency should be classified by the researcher. They could not be positively classified as being from Virginia, nor could they positively be classified as being from elsewhere. Perhaps one of them was a dual citizen, but it was ambiguous. Thus, the researcher (P. Rogers) did not include their data in the data for the “# of Physics PhD Degrees Awarded (VA Residents).” However, the researcher did include their data in the data for “# of PhD Degrees Awarded” because this particular data column, technically, did not list anything about the students’ home state or country. The fact that the researcher (P. Rogers) did not include these two ambiguous cases into the data column for “# of PhD Degrees Awarded (VA Residents)” could possibly slightly alter the value of the percentage calculated for “% VA Residents” for the Year 2011 (PhD degrees). It could also possibly slightly alter the TOTAL percentage calculated for “% VA Residents” (PhD degrees).

Demographic Statistics (Obtained from the Instructor Survey Forms) for the Entire Sample of “Physics Instructors Surveyed” (N_{PI} = 16)

Within the category termed “Physics Instructors Surveyed” (N_{PI} = 16), the researcher included those 16 physicists who turned in completed survey forms. At the time when the surveys were conducted, these physicists were employed (or had previously been employed) at the university level in the state of Mississippi, USA. There were 19 physicists (from Mississippi universities) whom the researcher either interviewed or received completed survey forms from; indeed, in most cases, the researcher both interviewed the physicist and received a completed survey form from that respective physicist. From these original 19 physicists in the overall pool of physicists, the researcher received 16 completed survey forms (some of them being anonymously sent through mail to the researcher).

The individuals from the original pool of 19 physicists are individuals who (a) are presently employed as physics professors at the university level; or (b) were employed as physics professors at the university level in the past; or (c) are professional physicists who work (or previously worked) in a research capacity at the university level. All of these 16 physicists (who were surveyed) worked or once worked at the university level in the state of Mississippi, USA. The original pool of 19 physicists (whom the researcher either surveyed or interviewed) consisted of the following: one physicist from the University of Southern Mississippi, two physicists from Mississippi State University, and sixteen physicists from the University of Mississippi. Of this original pool of 19 physicists, 16 of them turned in completed survey forms—some forms being anonymously sent to the researcher through the mail, and all of the forms being nameless due to the fact that the surveys were meant to be anonymous and thus had no slot for the name of each physicist.

Due to the fact that the forms were meant to be anonymous (and thus have no names on them), the researcher is not certain exactly which particular 16 of the original 19 physicists turned in completed survey forms—although the researcher does know the identity of many of those who turned in completed survey forms. The researcher does know that the 16 completed survey forms came from the pool of the original 19 physicists whom the researcher either interviewed or gave surveys to—or both. Thus, it can be said that these 16 survey responders in this particular sample (N_{PI} = 16) represent a sample consisting of physicists who are or once were employed at the university level in Mississippi; and a high percentage of them work or previously worked at the University of Mississippi.

The descriptive statistics for certain demographic data and survey results of the 16 physicists (often labeled in the survey data tables as “physics instructors”) are shown in Table 31-Table 45 which follow. Also, in the following pages, the written responses of the physicists (i.e. “physics instructors”) to the short-answer survey questions are shown. The theme tables which categorize their responses are also shown in Table 46-Table 48.

Table 31

Gender of the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) who Took the Survey

Gender	Number of Instructors	% of Sample (N_{PI} = 16)
Male	15	93.8 %
Female	1	6.3 %

Table 32

Country of Birth for the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) who Took the Survey

Country of Birth	Number of Instructors	% of Sample (N_{PI} = 16)
United States	11	68.8 %
India	2	12.5 %
Italy	1	6.3 %
Switzerland	1	6.3 %
No Answer was Given	1	6.3 %

Table 33

U.S. State of Birth for the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) who Took the Survey

State of Birth	Number of Instructors	% of Sample (N_{PI} = 16)
Mississippi	3	18.8 %
California	2	12.5 %
Tennessee	2	12.5 %
Kentucky	1	6.3 %
Louisiana	1	6.3 %
New York	1	6.3 %
An Unspecified U.S. State (Other than Mississippi)	1	6.3 %
A Non-USA State was Given	1	6.3 %
No Answer was Given	4	25.0%

Note 1. The above table should not be interpreted to be a representative sample (as far as percentages go) for the entire population of physics professors/research physicists at the three major universities in Mississippi (i.e. the University of Mississippi, Mississippi State University, and the University of Southern Mississippi). Indeed, the researcher (P. Rogers) purposely conducted a search in order to find 5 "native-Mississippian" physicists (i.e. physicists who were born and mostly educated in Mississippi) to include within this research project; and this search proved to be somewhat difficult. Three of the 5 native-Mississippian physicists were already retired. Another one of the professors who was classified (by the researcher) as a native-Mississippian was actually born in another state but moved to Mississippi as an infant (just a few months old). Nevertheless, the fact that there are a higher percentage of Mississippi physics instructors (i.e. physics professors) in the above table than physics instructors (i.e. physics professors) from any other state cannot be assumed to be necessarily representative of the entire population of physics professors/research physicists who work in Mississippi at the three major state universities. Indeed, the researcher (P. Rogers) is not sure of the exact breakdown of the percentages (based on state of birth) for the entire population of physics professors/research physicists who work at the three major universities in Mississippi. But, the percentages above cannot be assumed to reflect the percentages of the general population of physics professors/research physicists who work at the three major universities in Mississippi, because the researcher (P. Rogers) actively searched in order to find 5 Mississippi physicists/physics professors who could be classified as "native-Mississippian" physicists. Thus, the above data table likely reflects a higher than normal percentage of physics professors from Mississippi.
Note 2. Of course, some of the physics professors were not born in the USA, and so they answered with an answer other than a U.S. state (or else they left this question blank).

Table 34

Answers Given by the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) to the Demographic Question on the Instructor Survey Form, "Did you take physics at a Mississippi high school? (yes or no)"

Answer	Number of Instructors	% of Sample (N_{PI} = 16)
Yes	3	18.8 %
No	13	81.3 %

Table 35

Answers Given by the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) to the Demographic Question on the Instructor Survey Form, "In which state (or country) did you obtain most of your high school education?"

Answer	Number of Instructors	% of Sample (N_{PI} = 16)
Mississippi	4	25.0 %
Tennessee	2	12.5 %
Alabama	1	6.3 %
California	1	6.3 %
Kentucky	1	6.3 %
Louisiana	1	6.3 %
India	2	12.5 %
Italy	1	6.3 %
Spain	1	6.3 %
An Unspecified U.S. State (Other than MS)	1	6.3 %
No Answer was Given	1	6.3 %

Table 36

Ethnicity as Chosen from the List Provided on the Instructor Survey Form (or as Listed Separately) by the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16)

Ethnicity	Number of Instructors	% of Sample (N_{PI} = 16)
European-American	11	68.8 %
Indian (from India)	2	12.5 %
European	1	6.3 %
No Answer was Chosen	2	12.5 %

Note. The ethnicity shown in italics was listed by the instructor separately from the list of ethnicity choices provided on the Instructor Survey Form.

Survey Results from the Answers Given by the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) to the 9 Multiple-Choice Questions on the Instructor Survey Form

Table 37

Survey Results for the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) to Question #1 on the Instructor Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Instructors	% of Sample (N_{PI} = 16)
Yes	15	93.8 %
No	1	6.3 %
I do not know	0	0.0 %

Table 38

Survey Results for the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) to Question #2 on the Instructor Survey Form, "During what time period of your life did you begin to develop an interest in physics?"

Answer	Number of Instructors	% of Sample (N_{PI} = 16)
before the age of 12	3	18.8 %
between the ages of 12 and 15	4	25.0 %
between the ages of 15 and 18	7	43.8 %
between the ages of 18 and 21	2	12.5 %
after age 21	0	0.0 %

Table 39

Survey Results for the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) to Question #3 on the Instructor Survey Form, "During what time period of your life did you begin to conduct serious academic work towards increasing your skill in physics?"

Answer	Number of Instructors	% of Sample (N_{PI} = 16)
before the age of 12	1	6.3 %
between the ages of 12 and 15	2	12.5 %
between the ages of 15 and 18	6	37.5 %
between the ages of 18 and 21	5	31.3 %
after age 21	1	6.3 %
More Than One Answer was Chosen	1	6.3 %

Table 40

Survey Results for the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) to Question #4 on the Instructor Survey Form, "Choose which factor is <u>more</u> *important in order for someone to become a good physicist."*

Answer	Number of Instructors	% of Sample (N_{PI} = 16)
A person must be born with greater natural mental abilities for physics.	4	25.0 %
A person must spend many hours in personal study of physics.	3	18.8 %
They are of the same importance.	8	50.0 %
No Answer was Chosen	1	6.3 %

Table 41

Survey Results for the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) to Question #5 on the Instructor Survey Form, "Which statement best represents your opinion?"

Answer	Number of Instructors	% of Sample (N_{PI} = 16)
The majority of people are born with the necessary mental capacity to become physicists when they reach adulthood.	4	25.0 %
The majority of people are **not** born with the necessary mental capacity to become physicists when they reach adulthood.	9	56.3 %
Neither of These Answers was Chosen (The Physicist Wrote, "Don't know")	1	6.3 %
No Answer was Chosen	2	12.5 %

Table 42

Survey Results for the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) to Question #6 on the Instructor Survey Form, "Which of the following best represents your beliefs concerning physics?"

Answer	Number of Instructors	% of Sample (N_{PI} = 16)
A religious student will usually be better at physics than other students.	0	0.0 %
A non-religious student will usually be better at physics than other students.	1	6.3 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	0	0.0 %
A student's religious views have no effect on whether or not that student will be good at physics.	14	87.5 %
None of the above.	1	6.3 %

Table 43

Survey Results for the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) to Question #7 on the Instructor Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Instructors	% of Sample (N_{PI} = 16)
They are generally **much better** in physics than students from other countries.	0	0.0 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	5	31.3 %
They are generally **a little worse** in physics than students from other countries.	3	18.8 %
They are generally **much worse** in physics than students from other countries.	5	31.3 %
No Answer was Chosen	3	18.8 %

Table 44

Survey Results for the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) to Question #8 on the Instructor Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Instructors	% of Sample (N_{PI} = 16)
They are generally **much better** in physics than students from other countries.	0	0.0 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	7	43.8 %
They are generally **a little worse** in physics than students from other countries.	4	25.0 %
They are generally **much worse** in physics than students from other countries.	1	6.3 %
No Answer was Chosen	3	18.8 %
More Than One Answer was Chosen	1	6.3 %

Table 45

Survey Results for the Entire Sample of "Physics Instructors Surveyed" (N_{PI} = 16) to Question #9 on the Instructor Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Instructors	% of Sample (N_{PI} = 16)
Females naturally have better mental ability for physics than males.	0	0.0 %
Males naturally have better mental ability for physics than females.	1	6.3 %
Females and males have the same mental ability for physics.	13	81.3 %
None of These Answers were Chosen (The Physicist Wrote, "I don't know.")	1	6.3 %
No Answer was Chosen	1	6.3 %

Instructors' Written Responses to Short-Answer Questions from the Instructor Survey Forms

Question # 10: Why did you choose to pursue a career in physics?

Instructor #1: I like to try to figure out how things work

Instructor #2: My motivation changed over the years, but initially it was because I was intrigued by the idea of understanding nature at the most basic level.

Instructor #3: My passion for the subject

Instructor #4: Interest in physics, did well in physics in high school and college

Instructor #5: It was the only subject I found interesting.

Instructor #6: We had some wonderful popular books by [Sir?] James Jeans and [H.G. Wells?] on Astrophysics and science in our library. We had an inspiring professor who gave wonderful popular lectures.

Instructor #7: I enjoy physics.

Instructor #8: It seemed to be a more interesting and challenging field of science.

Instructor #9: I like it!

Instructor #10: I liked mathematics and was curious about nature.

Instructor #11: Work with large clusters of computers.

Instructor #12: I loved it as a major.

Instructor #13: Loved what I knew of it, and "the times" chose me.

Instructor #14: When I was in grade 10 to 12. [Instructor probably misread question to be asking "when" instead of "why".]

Instructor #15: My high school physics course seemed to answer questions I had and provided explanations for many physical phenomena I observed. I enjoyed gaining an understanding of the way in which my world worked.

Instructor #16: I was interested in math and science. I had good teachers in these areas, worked hard, and was fairly well prepared. Funding for grad school was fairly good in the areas of nuclear physics and space exploration at that time due to the competition with the Russians.

<u>Question # 11</u>: Would you recommend a career in physics to students who are in the process of choosing a major?

Instructor #1: Only if they have math skills and a love of learning and a willingness to tackle hard problems.

Instructor #2: Yes, definitely, if they have an interest in it.

Instructor #3: Depends on their level of passion for the subject. The rewards are skewed toward the intellectual as opposed to the money.

Instructor #4: It is a great career for those with good math/logic skills

Instructor #5: Not unless that student truly loves physics and has some talent for it.

Instructor #6: Yes. Physics still forms the basis on which all science stands. But it is a matter of taste. Some students may like chemistry and others may be drawn to biology. Everything should seem exciting to a young mind.

Instructor #7: Yes, if they are interested in physics and have the needed background math courses and proficiencies.

Instructor #8: If they were interested in science then yes I would.

Instructor #9: Only to some. I would like to evaluate them first to see if they have capabilities and motivation.

Instructor #10: Only if very serious about studies.

Instructor #11: Yes.

Instructor #12: Yes, if they enjoy the first classes and if it all "makes sense."

Instructor #13: Always if they have <u>any</u> interest or aptitude.

Instructor #14: Yes.

Instructor #15: I would if they had a natural inquisitiveness and aptitude for math.

Instructor #16: Yes, if they are interested in the subject areas and are willing to work hard.

<u>Question # 12</u>: In your opinion, what can be done to improve physics education in Mississippi so that students are better prepared for the rigors of physics?

Instructor #1: Math education needs to be greatly improved. Algebra and geometry skills need huge improvement.

Instructor #2: Improve the education of small children from very early on, make it interesting and challenging. Recruit good physics teachers in Mississippi high schools.

Instructor #3: Teach problem solving as opposed to rote memorization. More open ended projects that allow creativity.

Instructor #4: Good mathematics classes

Instructor #5: Better mathematical preparation. Critical thinking skills must be improved.

Instructor #6: (i) Dedicated teachers should be selected. (ii) They should be adequately supported financially to help them improve the teaching facilities in the school.

Instructor #7: Need better math and physics courses in high school and college.

Instructor #8: Having high school teachers who preferably have a degree in physics or at least in math or science, would be a big help. When the science teacher is "coach" I have my doubts as to the quality of his teaching. Also starting to teach math and science in middle and elementary school would greatly improve the preparedness of the high school physics students.

Instructor #9: Difficult question. Change the perception of how science is seen in the MS society and overhaul the educational system in the state, starting from K-12.

Instructor #10: More mathematical preparation in K-12. Tying in physics and math might work.

Instructor #11: Greater communication between Ole Miss and Miss. State and the high school physics classes.

Instructor #12: Students would be helped by having to solve more problems that have an application—story problems as we used to call them.

Instructor #13: Physics is not just a discipline! It is a way of Life, a way of seeing the world around you and more. Allow "Physics" as a course of study the freedom "to do".

Instructor #14: Better background in math. Math is the language of physics.

Instructor #15: We need to greatly increase the number of qualified math and physics teachers. The quality of science and math courses in the middle schools must also be improved to engender a change in student perception for the importance of math and science.

Instructor #16: Improve education in both elementary and high school. Insist that students meet high academic standards.

Thematic Analysis of the Written Responses of the Physics Instructors (N_{PI} = 16) to the Short-Answer Questions on the Instructor Survey Form

Table 46

Common Themes from the Written Responses of the Physics Instructors ($N_{Instructors\ Surveyed}$ = 16) to Question #10 on the Instructor Survey Form, "Why did you choose to pursue a career in physics?"

Thematic Category	Number of Physics Instructors	% of Sample ($N_{Instructors\ Surveyed}$ = 16)
Interest in, love of, or passion for the subject	13	81.3 %
Career/monetary reasons listed as a major reason	2	12.5 %
Other	1	6.3 %

Table 47

Common Themes from the Written Responses of the Physics Instructors ($N_{Instructors\ Surveyed}$ = 16) to Question #11 on the Instructor Survey Form, "Would you recommend a career in physics to students who are in the process of choosing a major?"

Thematic Category	Number of Physics Instructors	% of Sample ($N_{Instructors\ Surveyed}$ = 16)
Yes, definitely. [an almost unqualified yes]	7	43.8 %
Yes, but only if they have the talent, background, work ethic, etc. [a very qualified yes]	9	56.3 %

Table 48

Common Themes from the Written Responses of the Physics Instructors ($N_{Instructors\ Surveyed}$ = 16) to Question #12 on the Instructor Survey Form, "In your opinion, what can be done to improve physics education in Mississippi so that students are better prepared for the rigors of physics?"

Thematic Category	Number of Physics Instructors who Listed Each Point	% of Sample ($N_{Instructors\ Surveyed}$ = 16)
Improve math education; better math preparation.	7	43.8 %
Improve education/science education of young children, and of children in elementary or middle school (i.e. start from a young age).	4	25.0 %
Recruit qualified physics teachers in MS high schools; better physics preparation in high school.	5	31.3 %
Teach problem solving; improve critical thinking skills.	3	18.8 %
Allow more creativity, open-ended projects.	2	12.5 %
Improve education in high school.	1	6.3 %
Change perception of how science is seen in the state.	1	6.3 %
Greater communication between Ole Miss and Mississippi State and high school physics classes.	1	6.3 %
Improve math and physics courses in college.	1	6.3 %

Overhaul (i.e. completely redesign) entire educational system in the state, starting from K-12.	1	6.3 %
Insist that students meet high academic standards.	1	6.3 %
Improve financial support for teachers.	1	6.3 %

Note. For this table above, the researcher (P. Rogers) listed the number of physics instructors who listed each respective point (or theme category) in their written answers. Thus, it was possible for a professor's answer to match more than one thematic category—in which case the researcher (P. Rogers) put a mark by each thematic category that matched with the professor's answer.

General Demographic Statistics and Survey Results Obtained from the Student Surveys

Table 49

Sample of Pre-med Physics and Engineering Physics Students who were Surveyed, Categorized in Terms of the Class which was Surveyed

Student Number[a]	Physics Class Type	Date the Survey Was Given	Sample Size
#1-24	Pre-med Physics	24 April 2013	$N_1 = 24$
#25-49	Engineering Physics	24 April 2013	$N_2 = 25$
#50-62	Engineering Physics	24 July 2012	$N_3 = 13$
#63-87	Pre-med Physics	24 July 2012	$N_4 = 25$
#88-113	Engineering Physics	24 April 2013	$N_5 = 26$
			$N_{Total} = 113$

[a]The student number was a number the researcher assigned to each completed (or almost completed) survey form which was turned it. This allowed the researcher to keep up with each separate form without using names.

Table 50

Sample of Pre-med Physics and Engineering Physics Students who were Surveyed, Categorized Solely in Terms of the Type of Physics Class

Physics Class Type	Sample Size	% of Entire Sample Surveyed
Pre-med Physics	$N_P = 49$	43.4 %
Engineering Physics	$N_E = 64$	56.6 %
	$N_{Total} = 113$	

Table 51

Sample of Pre-med Physics and Engineering Physics Students who were Surveyed, Categorized Solely in Terms of Whether the Students were Summer Students or Spring Semester Students

Semester Type	Sample Size	% of Entire Sample Surveyed
Total Summer Semester Physics Students Surveyed	$N_{SU} = 38$	33.6 %
Total Spring Semester Physics Students Surveyed	$N_{SP} = 75$	66.4 %
	$N_{Total} = 113$	

Table 52

Answers Given by Entire Group of Physics Students (N_{Total} = 113) to the Demographic Question, "What is your major?"

Major	Number of Students With this Type of Major	% of Sample (N_{Total} = 113)
Life Sciences		
Biochemistry (6), Biochemistry Pre-med (2)	8	7.1 %
Biology (9), Biology/Spanish (Pre-dental) (1), Biology/Psychology (2)	12	10.6 %
Exercise Science (7), Pre-Med Exercise Science (1), Exercise Major (1)	9	8.0 %
Pharmaceutical Science (2), Pre-pharmacy (3), Pharmacy (6), Pre-Rx (1)	12	10.6 %
Physical Therapy	1	0.9 %
Physical Sciences and Engineering		
Chemical Engineering	17	15.0 %
Chemistry	3	2.7 %
Civil Engineering	6	5.3 %
Computer Science	1	0.9 %
Electrical Engineering	2	1.8 %
Forensic Chemistry	6	5.3 %
General Engineering	1	0.9 %

Geological Engineering (5), Geological Engineering and Physics (1)	6	5.3 %
Geology	1	0.9 %
Mechanical Engineering (18), Mechanical Engineering and Spanish (1)	19	16.8 %
Physics (2), Physics and Biochemistry (1)	3	2.7 %
Other		
Business	1	0.9 %
English	1	0.9 %
PRL Journalism	1	0.9 %
Mathematics/Biochemistry	1	0.9 %
Psychology	1	0.9 %
Vocal Performance	1	0.9 %

Table 53

Age Range of the Entire Group of Physics Students (N_{Total} = 113) who Took the Survey

Age	Number of Students	% of Sample (N_{Total} = 113)
19-21	99	87.6 %
22-24	10	8.8 %
25-27	3	2.7 %
No Age Listed	1	0.9 %

Table 54

Gender of the Entire Group of Physics Students (N_{Total} = 113) who Took the Survey

Gender	Number of Students	% of Sample (N_{Total} = 113)
Male	72	63.7 %
Female	41	36.3 %

Table 55

Gender of the Physics Students (N_E = 64) from the Engineering Physics Labs who Took the Survey

Gender	Number of Students	% of Sample (N_E = 64)
Male	46	71.9 %
Female	18	28.1 %

Table 56

Gender of the Physics Students (N_P = 49) from the Pre-Med Physics Labs who Took the Survey

Gender	Number of Students	% of Sample (N_P = 49)
Male	26	53.1 %
Female	23	46.9 %

Table 57

Country of Birth for the Entire Group of Physics Students (N_{Total} = 113) who Took the Survey

Country of Birth	Number of Students	% of Sample (N_{Total} = 113)
United States	107	94.7 %
Malaysia	1	0.9 %
Mexico	1	0.9 %
Nigeria	1	0.9 %
Pakistan	1	0.9 %
Russia	1	0.9 %
Sri Lanka	1	0.9 %

Table 58

Country of Birth for the Physics Students (N_E = 64) from the Engineering Physics Labs who Took the Survey

Country of Birth	Number of Students	% of Sample (N_E = 64)
United States	59	92.2 %
Malaysia	1	1.6 %
Mexico	1	1.6 %
Nigeria	1	1.6 %
Russia	1	1.6 %
Sri Lanka	1	1.6 %

Table 59

Country of Birth for the Physics Students (N_P = 49) from the Pre-Med Physics Labs who Took the Survey

Country of Birth	Number of Students	% of Sample (N_P = 49)
United States	48	98.0 %
Pakistan	1	2.0 %

Table 60

State of Birth for the USA-Born Physics Students (N_{USA} = 107) who Took the Survey

State of Birth	Number of Students	% of Sample (N_{USA} = 107)
Mississippi	56	52.3 %
Tennessee	10	9.4%
Georgia	7	6.5 %
Louisiana	6	5.6 %
Alabama	5	4.7 %
Texas	4	3.7 %
Arkansas	3	2.8 %
Missouri	3	2.8 %
California	2	1.9 %
Kentucky	2	1.9 %
Pennsylvania	2	1.9 %
Illinois	1	0.9 %
Maine	1	0.9 %
Maryland	1	0.9 %
New Mexico	1	0.9 %
Ohio	1	0.9 %
South Carolina	1	0.9 %
Virginia	1	0.9 %

Table 61

Summary of Place of Birth for the Entire Group of Physics Students (N_{Total} = 113) who Took the Survey

Place of Birth	Number of Students	% of Sample (N_{Total} = 113)
Born in MS	56	49.6 %
Born in Other US States	51	45.1 %
Born in Countries Other than the USA	6	5.3 %

Table 62

U.S. State in which the Physics Students Obtained Most of their High School Education (N_{Total} = 113)

U.S. State	Number of Students	% of Sample (N_{Total} = 113)
Mississippi	70	62.0 %
Tennessee	9	8.0 %
Georgia	6	5.3 %
Texas	5	4.4 %
Louisiana	4	3.5 %
Missouri	4	3.5 %
Alabama	3	2.7 %
Kentucky	2	1.8 %
South Carolina	2	1.8 %
Illinois	1	0.9 %
Maryland	1	0.9 %
New Mexico	1	0.9 %
New York	1	0.9 %
Ohio	1	0.9 %
Not Applicable (Non-U.S. Locations or No Answer Given)	3	2.7 %

Table 63

Summary of Information for the State in Which the Physics Students (N_{Total} = 113) Obtained Most of their High School Education

Place Where Most of High School Education was Obtained	Number of Students	% of Sample (N_{Total} = 113)
Mississippi	70	62.0 %
Another U.S. State	40	35.4 %
Not Applicable (Non-U.S. Locations or No Answer Given)	3	2.7 %

Table 64

Answers Given by Entire Group of Physics Students (N_{Total} = 113) to the Demographic Question, "Did you take physics at a Mississippi High School? (yes or no)"

Answer	Number of Students	% of Sample (N_{Total} = 113)
Yes	44	38.9 %
No	68	60.2 %
Other	1	0.9 %

Table 65

Answers Given by the Engineering Physics Students (N_E = 64) to the Demographic Question, "Did you take physics at a Mississippi High School? (yes or no)"

Answer	Number of Students	% of Sample (N_E = 64)
Yes	24	37.5 %
No	40	62.5 %

Table 66

Answers Given by the Pre-Med Physics Students (N_P = 49) to the Demographic Question, "Did you take physics at a Mississippi High School? (yes or no)"

Answer	Number of Students	% of Sample (N_P = 49)
Yes	20	40.8 %
No	28	57.1 %
Other	1	2.0 %

Table 67

Ethnicity as Chosen from the List Provided on the Student Survey Form (or as Listed Separately) by the Entire Group of Physics Students (N_{Total} = 113)

Ethnicity	Number of Students	% of Sample (N_{Total} = 113)
African-American	13	11.5 %
European-American	60	53.1 %
White	9	8.0 %
Caucasian[a]	6	5.3 %
White-Caucasian	1	0.9 %
European-American and Native-American	1	0.9 %
European-American and Asian-American	1	0.9 %
Latin-American	2	1.8 %
Asian-American	5	4.4 %
Lebanese-American	1	0.9 %
African	1	0.9 %
Cajun	1	0.9 %
India (not from India)	1	0.9 %
American	3	2.7 %
No Answer Given (Left Blank)	8	7.1 %

Note. The ethnicities in italics were listed by the student/s separately from the ethnicities provided on the Student Survey Form; or in some cases, a student circled more than one of the ethnicity choices, in which case the researcher (P. Rogers) described their ethnicity as a combination of the choices they circled. These types of responses, which differed from the ethnicity choices provided on the survey form, possibly represent a "self-identification" of the student/s with a certain ethnicity which was not listed on the form. Also, the fact that this question was listed as "Optional" on the survey form might help to explain (or partially explain) why several students chose to leave the question unanswered.
[a]One student listed "caucassian" which the researcher took to be an incorrect spelling of "caucasian."

Survey Results from the Answers Given by the Entire Group of Physics Students (N_{Total} = 113) to the 16 Multiple-Choice Questions on the Student Survey

Table 68

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
Yes	108	95.6 %
No	4	3.5 %
I do not know	1	0.9 %

Table 69

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
0	32	28.3 %
1	58	51.3 %
2	21	18.6 %
3	1	0.9 %
more than 3	0	0.0 %
No Answer (Left Blank)	1	0.9 %

Table 70

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
A	58	51.3 %
B	18	15.9 %
C	1	0.9 %
D	2	1.8 %
F	0	0.0%
Not Applicable	33	29.2 %
No Answer (Left Blank)	1	0.9 %

Table 71

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
0	0	0.0 %
1	7	6.2 %
2	105	92.9 %
3	1	0.9 %
more than 3	0	0.0 %

Table 72

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
A	60	53.1 %
B	39	34.5 %
C	12	10.6 %
D	2	1.8 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 73

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
Very easy	9	8.0 %
Easy	8	7.1 %
Medium Difficulty	29	25.7 %
Difficult	27	23.9 %
Very Difficult	8	7.1 %
Not Applicable, I never have taken a high school physics course	30	26.6 %
No Answer/Chose more than one answer	2	1.8 %

Table 74

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
Very easy	1	0.9 %
Easy	5	4.4 %
Medium Difficulty	43	38.1 %
Difficult	48	42.5 %
Very Difficult	16	14.2 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 75

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
Excellent	38	33.6 %
Above Average	57	50.4 %
Average	17	15.0 %
Below Average	1	0.9 %
Poor	0	0.0 %

Table 76

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
Excellent	9	8.0 %
Above Average	49	43.4 %
Average	47	41.6 %
Below Average	5	4.4 %
Poor	1	0.9 %
Chose More than One Answer/No Answer (left blank)	2	1.8 %

Table 77

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
Much better	13	11.5 %
Better	19	16.8 %
The Same	60	53.1 %
Worse	12	10.6 %
Much Worse	1	0.9 %
No Answer (left blank)	8	7.1 %

Table 78

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #11 on the Student Survey Form, "Choose which factor is more important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_{Total} = 113)
A person must be born with greater natural mental abilities for physics.	10	8.9 %
A person must spend many hours in personal study of physics.	52	46.0 %
They are of the same importance.	51	45.1 %

Table 79

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	47	41.6 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	64	56.6 %
No Answer was Chosen	2	1.8 %

Table 80

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
A religious student will usually be better at physics than other students.	2	1.8 %
A non-religious student will usually be better at physics than other students.	6	5.3 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	4	3.5 %
A student's religious views have no effect on whether or not that student will be good at physics.	95	84.1 %
None of the above.	4	3.5 %
No Answer was Chosen.	2	1.8 %

Table 81

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
They are generally **much better** in physics than students from other countries.	4	3.5 %
They are generally **a little better** in physics than students from other countries.	1	0.9 %
They are generally **the same** in physics as students from other countries.	34	30.1 %
They are generally **a little worse** in physics than students from other countries.	52	46.0 %
They are generally **much worse** in physics than students from other countries.	18	15.9 %
No Answer was Chosen	4	3.5 %

Note. One of the students who was born in Mississippi, USA, and who chose no answer, wrote the following explanatory message below Question #14: "I don't have enough info to answer this. I feel like MS students have had wonderful opportunities at Ole Miss to be competitive with any other nationality."

Table 82

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{Total} = 113)
They are generally **much better** in physics than students from other countries.	5	4.4 %
They are generally **a little better** in physics than students from other countries.	9	8.0 %
They are generally **the same** in physics as students from other countries.	46	40.7 %
They are generally **a little worse** in physics than students from other countries.	47	41.6 %
They are generally **much worse** in physics than students from other countries.	2	1.8 %
No Answer was Chosen/(or Two Answers were Chosen)	4	3.5 %

Note. One of the students who was born in Mississippi, USA, and who had chosen no answer, wrote the following explanatory message below Question #15: "I do not have enough information. I'm not entirely sure how good other countries are at physics but I feel like we are competitive."

Table 83

Survey Results for the Entire Group of Physics Students (N_{Total} = 113) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_{Total} = 113)
Females naturally have better mental ability for physics than males.	2	1.8 %
Males naturally have better mental ability for physics than females.	45	39.8 %
Females and males have the same mental ability for physics.	64	56.6 %
No Answer was Chosen	2	1.8 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of Female Physics Students (N_f = 41)

Table 84

Country of Birth for the Entire Sample of Female Physics Students (N_f = 41) as Listed in the Demographic Information by Those Who Took the Survey

Country of Birth	Number of Students	% of Sample (N_f = 41)
United States	38	92.7 %
Malaysia	1	2.4 %
Pakistan	1	2.4 %
Sri Lanka	1	2.4 %

Table 85

Three General Categories Relating to USA State of Birth for the Entire Sample of Female Physics Students (N_f = 41), as Gathered and Categorized from the answers to the Demographic Survey Question, "If you were born in the USA, please list the state you were born in:"

Answer	Number of Students	% of Sample (N_f = 41)
Students who listed MS as state of birth.	23	56.1 %
Students who listed another USA state (other than MS) as state of birth.	15	36.6 %
Students who left this question blank.	3	7.3 %

Table 86

Three General Categories Relating to the State in which Most of High School Education was Obtained for the Entire Sample of Female Physics Students (N_f = 41), as Gathered and Categorized from the answers to the Demographic Survey Question, "In which state did you obtain most of your high school education ?"

Answer	Number of Students	% of Sample (N_f = 41)
Students who listed MS.	28	68.3 %
Students who listed another USA state other than MS.	12	29.3 %
Students who listed an abbreviation that was not a USA state.	1	2.4 %

Table 87

Answers Given by the Entire Sample of Female Physics Students (N_f = 41) to the Demographic Question on the Student Survey Form, "Did you take physics at a Mississippi high school? (yes or no)"

Answer	Number of Students	% of Sample (N_f = 41)
Yes	15	36.6 %
No	26	63.4 %

Survey Results from the Answers Given by the Entire Sample of Female Physics Students (N_f = 41) to the 16 Multiple-Choice Questions on the Student Survey

Table 88

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample (N_f = 41)
Yes	38	92.7 %
No	2	4.9 %
I do not know	1	2.4 %

Table 89

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample (N_f = 41)
0	15	36.6 %
1	21	51.2 %
2	5	12.2 %
3	0	0.0 %
more than 3	0	0.0 %

Table 90

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_f = 41)
A	18	43.9 %
B	6	14.6 %
C	0	0.0 %
D	1	2.4 %
F	0	0.0 %
Not Applicable	16	39.0 %

Table 91

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_f = 41)
0	0	0.0 %
1	1	2.4 %
2	40	97.6 %
3	0	0.0 %
more than 3	0	0.0 %

Table 92

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_f = 41)
A	22	53.7 %
B	14	34.2 %
C	5	12.2 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 93

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_f = 41)
Very easy	3	7.3 %
Easy	3	7.3 %
Medium Difficulty	8	19.5 %
Difficult	8	19.5 %
Very Difficult	5	12.2 %
Not Applicable, I never have taken a high school physics course	14	34.2 %

Table 94

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_f = 41)
Very easy	0	0.0 %
Easy	2	4.9 %
Medium Difficulty	15	36.6 %
Difficult	16	39.0 %
Very Difficult	8	19.5 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 95

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_f = 41)
Excellent	15	36.6 %
Above Average	16	39.0 %
Average	10	24.4 %
Below Average	0	0.0 %
Poor	0	0.0 %

Table 96

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_f = 41)
Excellent	3	7.3 %
Above Average	16	39.0 %
Average	20	48.8 %
Below Average	1	2.4 %
Poor	0	0.0 %
No Answer was Chosen	1	2.4 %

Table 97

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_f = 41)
Much better	3	7.3 %
Better	6	14.6 %
The Same	24	58.5 %
Worse	4	9.8 %
Much Worse	0	0.0 %
No Answer (left blank)	4	9.8 %

Table 98

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #11 on the Student Survey Form, "Choose which factor is more important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_f = 41)
A person must be born with greater natural mental abilities for physics.	3	7.3 %
A person must spend many hours in personal study of physics.	18	43.9 %
They are of the same importance.	20	48.8 %

Table 99

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_f = 41)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	11	26.8 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	28	68.3 %
No Answer was Chosen	2	4.9 %

Table 100

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_f = 41)
A religious student will usually be better at physics than other students.	0	0.0 %
A non-religious student will usually be better at physics than other students.	1	2.4 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	2	4.9 %
A student's religious views have no effect on whether or not that student will be good at physics.	37	90.2 %
None of the above.	0	0.0 %
No Answer was Chosen.	1	2.4 %

Table 101

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_f = 41)
They are generally **much better** in physics than students from other countries.	1	2.4 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	15	36.6 %
They are generally **a little worse** in physics than students from other countries.	17	41.5 %
They are generally **much worse** in physics than students from other countries.	5	12.2 %
No Answer was Chosen	3	7.3 %

Table 102

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_f = 41)
They are generally **much better** in physics than students from other countries.	1	2.4 %
They are generally **a little better** in physics than students from other countries.	2	4.9 %
They are generally **the same** in physics as students from other countries.	16	39.0 %
They are generally **a little worse** in physics than students from other countries.	19	46.3 %
They are generally **much worse** in physics than students from other countries.	0	0.0 %
No Answer was Chosen	3	7.3 %

Table 103

Survey Results for the Entire Sample of Female Physics Students (N_f = 41) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_f = 41)
Females naturally have better mental ability for physics than males.	0	0.0 %
Males naturally have better mental ability for physics than females.	11	26.8 %
Females and males have the same mental ability for physics.	29	70.7 %
No Answer was Chosen	1	2.4 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of Male Physics Students (N_m = 72)

Table 104

Country of Birth for the Entire Sample of Male Physics Students (N_m = 72) as Listed in the Demographic Information by Those Who Took the Survey

Country of Birth	Number of Students	% of Sample (N_m = 72)
United States	69	95.8 %
Mexico	1	1.4 %
Nigeria	1	1.4 %
Russia	1	1.4 %

Table 105

Three General Categories Relating to USA State of Birth for the Entire Sample of Male Physics Students (N_m = 72), as Gathered and Categorized from the answers to the Demographic Survey Question, "If you were born in the USA, please list the state you were born in:"

Answer	Number of Students	% of Sample (N_m = 72)
Students who listed MS as state of birth.	33	45.8 %
Students who listed another USA state (other than MS) as state of birth.	36	50.0 %
Students who left this question blank.	3	4.2 %

Table 106

Three General Categories Relating to the State in which Most of High School Education was Obtained for the Entire Sample of Male Physics Students (N_m = 72), as Gathered and Categorized from the answers to the Demographic Survey Question, "In which state did you obtain most of your high school education ?"

Answer	Number of Students	% of Sample (N_m = 72)
Students who listed MS.	41	56.9 %
Students who listed another USA state other than MS.	28	38.9 %
Other	3	4.2 %

Table 107

Answers Given by the Entire Sample of Male Physics Students (N_m = 72) to the Demographic Question on the Student Survey Form, "Did you take physics at a Mississippi high school? (yes or no)"

Answer	Number of Students	% of Sample (N_m = 72)
Yes	29	40.3 %
No	42	58.3 %
No Answer Chosen	1	1.4 %

Survey Results from the Answers Given by the Entire Sample of Male Physics Students (N_m = 72) to the 16 Multiple-Choice Questions on the Student Survey

Table 108

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample (N_m = 72)
Yes	70	97.2 %
No	2	2.8 %
I do not know	0	0.0 %

Table 109

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample (N_m = 72)
0	17	23.6 %
1	37	51.4 %
2	16	22.2 %
3	1	1.4 %
more than 3	0	0.0 %
No Answer was Chosen	1	1.4 %

Table 110

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_m = 72)
A	40	55.6 %
B	12	16.7 %
C	1	1.4 %
D	1	1.4 %
F	0	0.0 %
Not Applicable	17	23.6 %
No Answer was Chosen	1	1.4 %

Table 111

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_m = 72)
0	0	0.0 %
1	6	8.3 %
2	65	90.3 %
3	1	1.4 %
more than 3	0	0.0 %

Table 112

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_m = 72)
A	38	52.8 %
B	25	34.7 %
C	7	9.7 %
D	2	2.8 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 113

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_m = 72)
Very easy	6	8.3 %
Easy	5	6.9 %
Medium Difficulty	21	29.2 %
Difficult	19	26.4 %
Very Difficult	3	4.2 %
Not Applicable, I never have taken a high school physics course	16	22.2 %
More than One Answer was Chosen	1	1.4 %
No Answer was Chosen	1	1.4 %

Table 114

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_m = 72)
Very easy	1	1.4 %
Easy	3	4.2 %
Medium Difficulty	28	38.9 %
Difficult	32	44.4 %
Very Difficult	8	11.1 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 115

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_m = 72)
Excellent	23	31.9 %
Above Average	41	56.9 %
Average	7	9.7 %
Below Average	1	1.4 %
Poor	0	0.0 %

Table 116

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_m = 72)
Excellent	6	8.3 %
Above Average	33	45.8 %
Average	27	37.5 %
Below Average	4	5.6 %
Poor	1	1.4 %
More than One Answer was Chosen	1	1.4 %

Table 117

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_m = 72)
Much better	10	13.9 %
Better	13	18.1 %
The Same	36	50.0 %
Worse	8	11.1 %
Much Worse	1	1.4 %
No Answer	4	5.6 %

Table 118

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #11 on the Student Survey Form, "Choose which factor is more important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_m = 72)
A person must be born with greater natural mental abilities for physics.	7	9.7 %
A person must spend many hours in personal study of physics.	34	47.2 %
They are of the same importance.	31	43.1 %

Table 119

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_m = 72)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	36	50.0 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	36	50.0 %

Table 120

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_m = 72)
A religious student will usually be better at physics than other students.	2	2.8 %
A non-religious student will usually be better at physics than other students.	5	6.9 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	2	2.8 %
A student's religious views have no effect on whether or not that student will be good at physics.	58	80.6 %
None of the above.	4	5.6 %
No Answer was Chosen.	1	1.4 %

Table 121

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_m = 72)
They are generally **much better** in physics than students from other countries.	3	4.2 %
They are generally **a little better** in physics than students from other countries.	1	1.4 %
They are generally **the same** in physics as students from other countries.	19	26.4 %
They are generally **a little worse** in physics than students from other countries.	35	48.6 %
They are generally **much worse** in physics than students from other countries.	13	18.1 %
No Answer was Chosen	1	1.4 %

Table 122

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_m = 72)
They are generally **much better** in physics than students from other countries.	4	5.6 %
They are generally **a little better** in physics than students from other countries.	7	9.7 %
They are generally **the same** in physics as students from other countries.	30	41.7 %
They are generally **a little worse** in physics than students from other countries.	28	38.9 %
They are generally **much worse** in physics than students from other countries.	2	2.8 %
More than One Answer was Chosen	1	1.4 %

Table 123

Survey Results for the Entire Sample of Male Physics Students (N_m = 72) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_m = 72)
Females naturally have better mental ability for physics than males.	2	2.8 %
Males naturally have better mental ability for physics than females.	34	47.2 %
Females and males have the same mental ability for physics.	35	48.6 %
No Answer was Chosen	1	1.4 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53)

Within the category termed "Mississippi Natives," the researcher has included all student survey respondents who were both born in Mississippi and received most of their high school education in Mississippi. If a student was born in another state, the researcher did not include them in the category of "Mississippi Natives" even if they received most of their high school education in Mississippi; and, if a student was born in Mississippi, but received most of their high school education outside of Mississippi, the researcher did not include them in the category of "Mississippi Natives;" instead, they would have either been listed in the category of “Other Americans” or in the category of “Internationals.” Also, sometimes the term “Mississippi Natives” might appear in the abbreviated form of “MS Natives.”

Table 124

Gender of the Entire Sample of “Mississippi Natives” Physics Students (N_{MS} = 53) who Took the Survey

Gender	Number of Students	% of Sample (N_{MS} = 53)
Male	30	56.6 %
Female	23	43.4 %

Table 125

Answers Given by the Entire Sample of “Mississippi Natives” Physics Students (N_{MS} = 53) to the Demographic Question on the Student Survey Form, “Did you take physics at a Mississippi high school? (yes or no)”

Answer	Number of Students	% of Sample (N_{MS} = 53)
Yes	28	52.8 %
No	25	47.2 %

Table 126

Ethnicity as Chosen from the List Provided on the Student Survey Form (or as Listed Separately) by the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53)

Ethnicity	Number of Students	% of Sample (N_{MS} = 53)
African-American	10	18.9 %
European-American	28	52.8 %
White	4	7.6 %
Caucasian	3	5.7 %
Asian-American	1	1.9 %
Lebanese-American	1	1.9 %
No Answer was Chosen	6	11.3 %

Note. The ethnicities in italics were listed by the student/s separately from the ethnicities provided on the Student Survey Form. These types of responses, which differed from the ethnicity choices provided on the survey form, possibly represent a "self-identification" of the student/s with a certain ethnicity which was not listed on the form. Also, the fact that this question was listed as "Optional" on the survey form might help explain (or partially explain) why several students chose to leave the question unanswered.

Survey Results from the Answers Given by the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to the 16 Multiple-Choice Questions on the Student Survey

Table 127

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
Yes	49	92.5 %
No	3	5.7 %
I do not know	1	1.9 %

Table 128

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
0	22	41.5 %
1	25	47.2 %
2	5	9.4 %
3	1	1.9 %
more than 3	0	0.0 %

Table 129

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
A	27	50.9 %
B	3	5.7 %
C	0	0.0 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	23	43.4 %

Table 130

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
0	0	0.0 %
1	2	3.8 %
2	51	96.2 %
3	0	0.0 %
more than 3	0	0.0 %

Table 131

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
A	30	56.6 %
B	16	30.2 %
C	6	11.3 %
D	1	1.9 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 132

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
Very easy	5	9.4 %
Easy	4	7.6 %
Medium Difficulty	7	13.2 %
Difficult	12	22.6 %
Very Difficult	4	7.6 %
Not Applicable, I never have taken a high school physics course	20	37.7 %
More than One Answer was Chosen	1	1.9 %

Table 133

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
Very easy	0	0.0 %
Easy	1	1.9 %
Medium Difficulty	24	45.3 %
Difficult	17	32.1 %
Very Difficult	11	20.8 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 134

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
Excellent	22	41.5 %
Above Average	23	43.4 %
Average	8	15.1 %
Below Average	0	0.0 %
Poor	0	0.0 %

Table 135

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
Excellent	7	13.2 %
Above Average	19	35.9 %
Average	23	43.4 %
Below Average	2	3.8 %
Poor	1	1.9 %
More than One Answer was Chosen	1	1.9 %

Table 136

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
Much better	5	9.4 %
Better	9	17.0 %
The Same	30	56.6 %
Worse	6	11.3 %
Much Worse	0	0.0 %
No Answer was Chosen	3	5.7 %

Table 137

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #11 on the Student Survey Form, "Choose which factor is <u>more</u> important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_{MS} = 53)
A person must be born with greater natural mental abilities for physics.	3	5.7 %
A person must spend many hours in personal study of physics.	22	41.5 %
They are of the same importance.	28	52.8 %

Table 138

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	25	47.2 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	27	50.9 %
No Answer was Chosen	1	1.9 %

Table 139

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
A religious student will usually be better at physics than other students.	0	0.0 %
A non-religious student will usually be better at physics than other students.	2	3.8 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	1	1.9 %
A student's religious views have no effect on whether or not that student will be good at physics.	45	84.9 %
None of the above.	3	5.7 %
No Answer was Chosen.	2	3.8 %

Table 140

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
They are generally **much better** in physics than students from other countries.	0	0.0 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	15	28.3 %
They are generally **a little worse** in physics than students from other countries.	32	60.4 %
They are generally **much worse** in physics than students from other countries.	4	7.6 %
No Answer was Chosen	2	3.8 %

Table 141

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{MS} = 53)
They are generally **much better** in physics than students from other countries.	1	1.9 %
They are generally **a little better** in physics than students from other countries.	3	5.7 %
They are generally **the same** in physics as students from other countries.	22	41.5 %
They are generally **a little worse** in physics than students from other countries.	24	45.3 %
They are generally **much worse** in physics than students from other countries.	1	1.9 %
No Answer was Chosen	1	1.9 %
More than One Answer was Chosen	1	1.9 %

Table 142

Survey Results for the Entire Sample of "Mississippi Natives" Physics Students (N_{MS} = 53) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_{MS} = 53)
Females naturally have better mental ability for physics than males.	0	0.0 %
Males naturally have better mental ability for physics than females.	26	49.1 %
Females and males have the same mental ability for physics.	27	50.9 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of "Other Americans" Physics Students ($N_A = 54$)

Within the category termed "Other Americans," the researcher has included all student survey respondents who were born in the USA, but not "born and educated" in Mississippi. Thus, the term "Other Americans" includes all students in the sample who were: (a) Born in a USA state other than Mississippi and obtained most of their high school education in a USA state other than Mississippi; (b) Born in a USA state other than Mississippi, but obtained most of their high school education in Mississippi; (c) Born in Mississippi, but obtained most of their high school education in a USA state other than Mississippi.

Table 143

Gender of the Entire Sample of "Other Americans" Physics Students ($N_A = 54$) who Took the Survey

Gender	Number of Students	% of Sample ($N_A = 54$)
Male	39	72.2 %
Female	15	27.8 %

Table 144

Ethnicity as Chosen from the List Provided on the Student Survey Form (or as Listed Separately) by the Entire Sample of "Other Americans" Physics Students (N_A = 54)

Ethnicity	Number of Students	% of Sample (N_A = 54)
African-American	3	5.6 %
European-American	31	57.4 %
White	5	9.3 %
Caucasian	3	5.6 %
White-Caucasian	1	1.9 %
European-American and Native-American	1	1.9 %
European-American and Asian-American	1	1.9 %
Native American	0	0.0 %
Latin-American	1	1.9 %
Asian-American	2	3.7 %
Indian (from India)	0	0.0 %
Chinese	0	0.0 %
Cajun	1	1.9 %
American	3	5.6 %
No Answer was Chosen	2	3.7 %

Note. The ethnicities in italics were listed by the student/s separately from the ethnicities provided on the Student Survey Form; or in some cases, a student circled more than one of the ethnicity choices, in which case the researcher described their ethnicity as a combination of the choices they circled. These types of responses, which differed from the ethnicity choices provided on the survey form, possibly represent a "self-identification" of the student/s with a certain ethnicity which was not listed on the form. Also, the fact that this question was listed as "Optional" on the survey form might help explain why some students chose to leave the question unanswered.

Survey Results from the Answers Given by the Entire Sample of "Other Americans" Physics Students ($N_A = 54$) to the 16 Multiple-Choice Questions on the Student Survey

Table 145

Survey Results for the Entire Sample of "Other Americans" Physics Students ($N_A = 54$) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample ($N_A = 54$)
Yes	53	98.2 %
No	1	1.9 %
I do not know	0	0.0 %

Table 146

Survey Results for the Entire Sample of "Other Americans" Physics Students ($N_A = 54$) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample ($N_A = 54$)
0	8	14.8 %
1	32	59.3 %
2	13	24.1 %
3	0	0.0 %
more than 3	0	0.0 %
No Answer was Chosen	1	1.9 %

Table 147

Survey Results for the Entire Sample of "Other Americans" Physics Students (N_A = 54) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_A = 54)
A	29	53.7 %
B	13	24.1 %
C	1	1.9 %
D	2	3.7 %
F	0	0.0 %
Not Applicable	8	14.8 %
No Answer was Chosen	1	1.9 %

Table 148

Survey Results for the Entire Sample of "Other Americans" Physics Students (N_A = 54) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_A = 54)
0	0	0.0 %
1	5	9.3 %
2	48	88.9 %
3	1	1.9 %
more than 3	0	0.0 %

Table 149

Survey Results for the Entire Sample of "Other Americans" Physics Students ($N_A = 54$) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample ($N_A = 54$)
A	28	51.9 %
B	20	37.0 %
C	5	9.3 %
D	1	1.9 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 150

Survey Results for the Entire Sample of "Other Americans" Physics Students ($N_A = 54$) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample ($N_A = 54$)
Very easy	4	7.4 %
Easy	4	7.4 %
Medium Difficulty	21	38.9 %
Difficult	13	24.1 %
Very Difficult	3	5.6 %
Not Applicable, I never have taken a high school physics course	8	14.8 %
No Answer was Chosen	1	1.9 %

Table 151

Survey Results for the Entire Sample of "Other Americans" Physics Students (N_A = 54) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_A = 54)
Very easy	1	1.9 %
Easy	3	5.6 %
Medium Difficulty	19	35.2 %
Difficult	27	50.0 %
Very Difficult	4	7.4 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 152

Survey Results for the Entire Sample of "Other Americans" Physics Students (N_A = 54) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_A = 54)
Excellent	16	29.6 %
Above Average	30	55.6 %
Average	7	13.0 %
Below Average	1	1.9 %
Poor	0	0.0 %

Table 153

Survey Results for the Entire Sample of "Other Americans" Physics Students (N_A = 54) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_A = 54)
Excellent	2	3.7 %
Above Average	27	50.0 %
Average	21	38.9 %
Below Average	3	5.6 %
Poor	0	0.0 %
No Answer was Chosen	1	1.9 %

Table 154

Survey Results for the Entire Sample of "Other Americans" Physics Students (N_A = 54) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_A = 54)
Much better	7	13.0 %
Better	8	14.8 %
The Same	27	50.0 %
Worse	6	11.1 %
Much Worse	1	1.9 %
No Answer was Chosen	5	9.3 %

Table 155

Survey Results for the Entire Sample of "Other Americans" Physics Students (N_A = 54) to Question #11 on the Student Survey Form, "Choose which factor is <u>more</u> important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_A = 54)
A person must be born with greater natural mental abilities for physics.	6	11.1 %
A person must spend many hours in personal study of physics.	25	46.3 %
They are of the same importance.	23	42.6 %

Table 156

Survey Results for the Entire Sample of "Other Americans" Physics Students (N_A = 54) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_A = 54)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	20	37.0 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	33	61.1 %
No Answer was Chosen	1	1.9 %

Table 157

Survey Results for the Entire Sample of "Other Americans" Physics Students (N_A = 54) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_A = 54)
A religious student will usually be better at physics than other students.	2	3.7 %
A non-religious student will usually be better at physics than other students.	4	7.4 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	3	5.6 %
A student's religious views have no effect on whether or not that student will be good at physics.	44	81.5 %
None of the above.	1	1.9 %

Table 158

Survey Results for the Entire Sample of "Other Americans" Physics Students ($N_A = 54$) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample ($N_A = 54$)
They are generally **much better** in physics than students from other countries.	3	5.6 %
They are generally **a little better** in physics than students from other countries.	1	1.9 %
They are generally **the same** in physics as students from other countries.	18	33.3 %
They are generally **a little worse** in physics than students from other countries.	20	37.0 %
They are generally **much worse** in physics than students from other countries.	10	18.5 %
No Answer was Chosen	2	3.7 %

Table 159

Survey Results for the Entire Sample of "Other Americans" Physics Students (N_A = 54) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_A = 54)
They are generally **much better** in physics than students from other countries.	3	5.6 %
They are generally **a little better** in physics than students from other countries.	6	11.1 %
They are generally **the same** in physics as students from other countries.	23	42.6 %
They are generally **a little worse** in physics than students from other countries.	19	35.2 %
They are generally **much worse** in physics than students from other countries.	1	1.9 %
No Answer was Chosen	2	3.7 %

Table 160

Survey Results for the Entire Sample of "Other Americans" Physics Students (N_A = 54) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_A = 54)
Females naturally have better mental ability for physics than males.	2	3.7 %
Males naturally have better mental ability for physics than females.	17	31.5 %
Females and males have the same mental ability for physics.	33	61.1 %
No Answer was Chosen	2	3.7 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of "Internationals" Physics Students (N_I = 6)

Within the category termed "Internationals," the researcher has included all student survey respondents who were born in a country other than the USA. Although the "Internationals" were born in another country, the majority of them (4 of 6, or 66.7%) obtained most of their high school education in Mississippi. However, only 2 of 6 (or 33.3%) of the "Internationals" took physics at a Mississippi high school. Also, 5 of the 6 students (or 83.3%) classified as "Internationals" were in the engineering physics II lab; the other one was in the pre-med physics II lab.

Table 161

Gender of the Entire Sample of "Internationals" Physics Students (N_I = 6) who Took the Survey

Gender	Number of Students	% of Sample (N_I = 6)
Male	3	50.0 %
Female	3	50.0 %

Table 162

Country of Birth for the Entire Sample of "Internationals" Physics Students (N_I = 6) who Took the Survey

Country of Birth	Number of Students	% of Sample (N_I = 6)
Malaysia	1	16.7 %
Mexico	1	16.7 %
Nigeria	1	16.7 %
Pakistan	1	16.7 %
Russia	1	16.7 %
Sri Lanka	1	16.7 %

Table 163

Three General Categories Relating to the State in which Most of High School Education was Obtained for the Entire Sample of "Internationals" Physics Students ($N_I = 6$), as Gathered and Categorized from the answers to the Demographic Survey Question, "In which state did you obtain most of your high school education ?"

Answer	Number of Students	% of Sample ($N_I = 6$)
Students who listed MS	4	66.7 %
Students who listed another USA state other than MS	0	0.0 %
Other	2	33.3%

Table 164

Answers Given by the Entire Sample of "Internationals" Physics Students ($N_I = 6$) to the Demographic Question on the Student Survey Form, "Did you take physics at a Mississippi high school? (yes or no)"

Answer	Number of Students	% of Sample ($N_I = 6$)
Yes	2	33.3 %
No	4	66.7 %

Table 165

Ethnicity as Chosen from the List Provided on the Student Survey Form (or as Listed Separately) by the Entire Sample of "Internationals" Physics Students (N_I = 6)

Ethnicity	Number of Students	% of Sample (N_I = 6)
European-American	1	16.7 %
Latin-American	1	16.7 %
Asian-American	2	33.3 %
African	1	16.7 %
India (not from India)	1	16.7 %

Note. The ethnicities in italics were listed by the student/s separately from the ethnicities provided on the Student Survey Form. These types of responses, which differed from the ethnicity choices provided on the survey form, possibly represent a "self-identification" of the student/s with a certain ethnicity which was not listed on the form.

Survey Results from the Answers Given by the Entire Sample of "Internationals" Physics Students (N_I = 6) to the 16 Multiple-Choice Questions on the Student Survey

Table 166

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample (N_I = 6)
Yes	6	100.0 %
No	0	0.0 %
I do not know	0	0.0 %

Table 167

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample (N_I = 6)
0	2	33.3 %
1	1	16.7 %
2	3	50.0 %
3	0	0.0 %
more than 3	0	0.0 %

Table 168

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_I = 6)
A	2	33.3 %
B	2	33.3 %
C	0	0.0 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	2	33.3 %

Table 169

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_I = 6)
0	0	0.0 %
1	0	0.0 %
2	6	100.0 %
3	0	0.0%
more than 3	0	0.0 %

Table 170

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_I = 6)
A	2	33.3 %
B	3	50.0 %
C	1	16.7 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 171

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_I = 6)
Very easy	0	0.0 %
Easy	0	0.0 %
Medium Difficulty	1	16.7 %
Difficult	2	33.3 %
Very Difficult	1	16.7 %
Not Applicable, I never have taken a high school physics course	2	33.3 %

Table 172

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_I = 6)
Very easy	0	0.0 %
Easy	1	16.7 %
Medium Difficulty	0	0.0 %
Difficult	4	66.7 %
Very Difficult	1	16.7 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 173

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample ($N_I = 6$)
Excellent	0	0.0 %
Above Average	4	66.7 %
Average	2	33.3 %
Below Average	0	0.0 %
Poor	0	0.0 %

Table 174

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample ($N_I = 6$)
Excellent	0	0.0 %
Above Average	3	50.0 %
Average	3	50.0 %
Below Average	0	0.0 %
Poor	0	0.0 %

Table 175

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_I = 6)
Much better	1	16.7 %
Better	2	33.3 %
The Same	3	50.0 %
Worse	0	0.0 %
Much Worse	0	0.0 %

Table 176

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #11 on the Student Survey Form, "Choose which factor is <u>*more*</u> *important in order for someone to become a good physicist."*

Answer	Number of Students	% of Sample (N_I = 6)
A person must be born with greater natural mental abilities for physics.	1	16.7 %
A person must spend many hours in personal study of physics.	5	83.3 %
They are of the same importance.	0	0.0 %

Table 177

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_I = 6)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	2	33.3 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	4	66.7 %

Table 178

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_I = 6)
A religious student will usually be better at physics than other students.	0	0.0 %
A non-religious student will usually be better at physics than other students.	0	0.0 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	0	0.0 %
A student's religious views have no effect on whether or not that student will be good at physics.	6	100.0 %
None of the above.	0	0.0 %

Table 179

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_I = 6)
They are generally **much better** in physics than students from other countries.	1	16.7 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	1	16.7 %
They are generally **a little worse** in physics than students from other countries.	0	0.0 %
They are generally **much worse** in physics than students from other countries.	4	66.7 %

Table 180

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_I = 6)
They are generally **much better** in physics than students from other countries.	1	16.7 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	1	16.7 %
They are generally **a little worse** in physics than students from other countries.	4	66.7 %
They are generally **much worse** in physics than students from other countries.	0	0.0 %

Table 181

Survey Results for the Entire Sample of "Internationals" Physics Students (N_I = 6) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_I = 6)
Females naturally have better mental ability for physics than males.	0	0.0 %
Males naturally have better mental ability for physics than females.	2	33.3 %
Females and males have the same mental ability for physics.	4	66.7 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13)

Within the category termed "African-Americans," the researcher has included all student survey respondents who chose "African-American" as their ethnicity on the optional question regarding ethnicity which was listed on the survey form.

Table 182

Gender of the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) who Took the Survey

Gender	Number of Students	% of Sample (N_{AA} = 13)
Male	7	53.9 %
Female	6	46.2 %

Table 183

Answers Given by the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to the Demographic Question on the Student Survey Form, "Did you take physics at a Mississippi high school? (yes or no)"

Answer	Number of Students	% of Sample (N_{AA} = 13)
Yes	5	38.5 %
No	8	61.5 %

Survey Results from the Answers Given by the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to the 16 Multiple-Choice Questions on the Student Survey

Table 184

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
Yes	10	76.9 %
No	2	15.4 %
I do not know	1	7.7 %

Table 185

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
0	8	61.5 %
1	4	30.8 %
2	1	7.7 %
3	0	0.0 %
more than 3	0	0.0 %

Table 186

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
A	5	38. 5 %
B	0	0.0 %
C	0	0.0 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	8	61.5 %

Table 187

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
0	0	0.0 %
1	1	7.7 %
2	12	92.3 %
3	0	0.0 %
more than 3	0	0.0 %

Table 188

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
A	4	30.8 %
B	5	38.5 %
C	4	30.8 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 189

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
Very easy	1	7.7 %
Easy	0	0.0 %
Medium Difficulty	3	23.1 %
Difficult	1	7.7 %
Very Difficult	0	0.0 %
Not Applicable, I never have taken a high school physics course	8	61.5 %

Table 190

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
Very easy	1	7.7 %
Easy	1	7.7 %
Medium Difficulty	3	23.1 %
Difficult	4	30.8 %
Very Difficult	4	30.8 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 191

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
Excellent	5	38.5 %
Above Average	6	46.2 %
Average	2	15.4 %
Below Average	0	0.0 %
Poor	0	0.0 %

Table 192

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
Excellent	1	7.7 %
Above Average	4	30.8 %
Average	7	53.9 %
Below Average	0	0.0 %
Poor	1	7.7 %

Table 193

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
Much better	1	7.7 %
Better	0	0.0 %
The Same	7	53.9 %
Worse	4	30.8 %
Much Worse	0	0.0 %
No Answer was Chosen	1	7.7 %

Table 194

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #11 on the Student Survey Form, "Choose which factor is <u>more</u> important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_{AA} = 13)
A person must be born with greater natural mental abilities for physics.	1	7.7 %
A person must spend many hours in personal study of physics.	8	61.5 %
They are of the same importance.	4	30.8 %

Table 195

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	6	46.2 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	7	53.9 %

Table 196

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
A religious student will usually be better at physics than other students.	1	7.7 %
A non-religious student will usually be better at physics than other students.	0	0.0 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	0	0.0 %
A student's religious views have no effect on whether or not that student will be good at physics.	10	76.9 %
None of the above.	2	15.4 %

Table 197

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
They are generally **much better** in physics than students from other countries.	0	0.0 %
They are generally **a little better** in physics than students from other countries.	1	7.7 %
They are generally **the same** in physics as students from other countries.	3	23.1 %
They are generally **a little worse** in physics than students from other countries.	7	53.9 %
They are generally **much worse** in physics than students from other countries.	1	7.7 %
No Answer was Chosen	1	7.7 %

Table 198

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{AA} = 13)
They are generally **much better** in physics than students from other countries.	1	7.7 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	6	46.2 %
They are generally **a little worse** in physics than students from other countries.	5	38.5 %
They are generally **much worse** in physics than students from other countries.	0	0.0 %
No Answer was Chosen	1	7.7 %

Table 199

Survey Results for the Entire Sample of "African-Americans" Physics Students (N_{AA} = 13) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_{AA} = 13)
Females naturally have better mental ability for physics than males.	1	7.7 %
Males naturally have better mental ability for physics than females.	4	30.8 %
Females and males have the same mental ability for physics.	7	53.9 %
No Answer was Chosen	1	7.7 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76)

Within the category termed "European-Americans," the researcher has included all student survey respondents who chose "European-American" as their ethnicity on the optional question regarding ethnicity which was listed on the survey form. The researcher also included within this category labeled as "European-Americans" all the students who chose the ethnicity choice labeled as "Other" and then also listed their ethnicity in the blank beside the "Other" choice as being "White," "Caucasian," or "White-Caucasian"; the researcher included them within the "European-Americans" sample because in the USA, the words "White" and "Caucasian" are words which are commonly used to describe "European-Americans." Thus, this sample which is labeled as “European-Americans” includes: (1) those students who chose “European-American” as their ethnicity, and (2) those students who chose the ethnicity choice labeled as “Other” and then (in the nearby blank) listed “White,” “Caucasian,” or “White-Caucasian” as their ethnicity. In all other cases of students who chose the ethnicity choice labeled as “Other,” the researcher grouped them into a sample labeled “Other Ethnicities.” In a couple of cases, a student chose two ethnicities among the various ethnicity choices. For example, one student chose both “European-American” and “Asian-American” as their ethnicity. Another student chose “European-American” and “Native-American” as their ethnicity. Instead of grouping these two students (who chose two ethnicities) into the “European-Americans” sample, the researcher included them within the “Other Ethnicities” sample. The researcher did this because they had listed two equally important ethnicities as part of their ethnic identity; thus they could not properly be categorized as just one of the ethnicities. One of the students in the “European-Americans” sample was not born in the USA. Instead, this student was born in Russia. However, because the student chose “European-American” as his or her ethnicity choice, the student was included in the sample of students labeled as “European-Americans.”

Table 200

Gender of the Entire Sample of “European-Americans” Physics Students (N_{EA} = 76) *who Took the Survey*

Gender	Number of Students	% of Sample (N_{EA} = 76)
Male	50	65.8 %
Female	26	34.2 %

Table 201

Answers Given by the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to the Demographic Question on the Student Survey Form, "Did you take physics at a Mississippi high school? (yes or no)"

Answer	Number of Students	% of Sample (N_{EA} = 76)
Yes	32	42.1 %
No	43	56.6 %
Other	1	1.3 %

Survey Results from the Answers Given by the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to the 16 Multiple-Choice Questions on the Student Survey

Table 202

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
Yes	75	98.7 %
No	1	1.3 %
I do not know	0	0.0 %

Table 203

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
0	16	21.1 %
1	43	56.6 %
2	16	21.1 %
3	1	1.3 %
more than 3	0	0.0 %

Table 204

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
A	44	57.9 %
B	13	17.1 %
C	1	1.3 %
D	1	1.3 %
F	0	0.0 %
Not Applicable	17	22.4 %

Table 205

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
0	0	0.0 %
1	5	6.6 %
2	71	93.4 %
3	0	0.0 %
more than 3	0	0.0 %

Table 206

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
A	43	56.6 %
B	26	34.2 %
C	5	6.6 %
D	2	2.6 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 207

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
Very easy	6	7.9 %
Easy	5	6.6 %
Medium Difficulty	21	27.6 %
Difficult	22	29.0 %
Very Difficult	7	9.2 %
Not Applicable, I never have taken a high school physics course	14	18.4 %
More Than One Answer was Chosen	1	1.3 %

Table 208

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
Very easy	0	0.0 %
Easy	2	2.6 %
Medium Difficulty	32	42.1 %
Difficult	33	43.4 %
Very Difficult	9	11.8 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 209

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
Excellent	28	36.8 %
Above Average	36	47.4 %
Average	12	15.8 %
Below Average	0	0.0 %
Poor	0	0.0 %

Table 210

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
Excellent	7	9.2 %
Above Average	36	47.4 %
Average	28	36.8 %
Below Average	4	5.3 %
Poor	0	0.0 %
More Than One Answer was Chosen	1	1.3 %

Table 211

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
Much better	8	10.5 %
Better	12	15.8 %
The Same	43	56.6 %
Worse	7	9.2 %
Much Worse	1	1.3 %
No Answer was Chosen	5	6.6 %

Table 212

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #11 on the Student Survey Form, "Choose which factor is more important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_{EA} = 76)
A person must be born with greater natural mental abilities for physics.	7	9.2 %
A person must spend many hours in personal study of physics.	31	40.8 %
They are of the same importance.	38	50.0 %

Table 213

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	34	44.7 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	41	54.0 %
No Answer was Chosen	1	1.3 %

Table 214

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
A religious student will usually be better at physics than other students.	1	1.3 %
A non-religious student will usually be better at physics than other students.	6	7.9 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	3	4.0 %
A student's religious views have no effect on whether or not that student will be good at physics.	64	84.2 %
None of the above.	0	0.0 %
No Answer was Chosen	2	2.6 %

Table 215

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
They are generally **much better** in physics than students from other countries.	2	2.6 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	25	32.9 %
They are generally **a little worse** in physics than students from other countries.	35	46.1 %
They are generally **much worse** in physics than students from other countries.	11	14.5 %
No Answer was Chosen	3	4.0 %

Table 216

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{EA} = 76)
They are generally **much better** in physics than students from other countries.	3	4.0 %
They are generally **a little better** in physics than students from other countries.	5	6.6 %
They are generally **the same** in physics as students from other countries.	30	39.5 %
They are generally **a little worse** in physics than students from other countries.	35	46.1 %
They are generally **much worse** in physics than students from other countries.	1	1.3 %
No Answer was Chosen	1	1.3 %
More than One Answer was Chosen	1	1.3 %

Table 217

Survey Results for the Entire Sample of "European-Americans" Physics Students (N_{EA} = 76) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_{EA} = 76)
Females naturally have better mental ability for physics than males.	0	0.0 %
Males naturally have better mental ability for physics than females.	32	42.1 %
Females and males have the same mental ability for physics.	44	57.9 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5)

Within the category termed "Asian-Americans," the researcher has included all student survey respondents who chose "Asian-American" as their ethnicity on the optional question regarding ethnicity which was listed on the survey form.

Table 218

Gender of the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) who Took the Survey

Gender	Number of Students	% of Sample (N_{AS} = 5)
Male	1	20.0 %
Female	4	80.0 %

Table 219

Answers Given by the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to the Demographic Question on the Student Survey Form, "Did you take physics at a Mississippi high school? (yes or no)"

Answer	Number of Students	% of Sample (N_{AS} = 5)
Yes	3	60.0 %
No	2	40.0 %

Survey Results from the Answers Given by the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to the 16 Multiple-Choice Questions on the Student Survey

Table 220

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
Yes	5	100.0 %
No	0	0.0 %
I do not know	0	0.0 %

Table 221

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
0	1	20.0 %
1	3	60.0 %
2	1	20.0 %
3	0	0.0 %
more than 3	0	0.0 %

Table 222

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
A	3	60.0 %
B	1	20.0 %
C	0	0.0 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	1	20.0 %

Table 223

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
0	0	0.0 %
1	1	20.0 %
2	4	80.0 %
3	0	0.0 %
more than 3	0	0.0 %

Table 224

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
A	4	80.0 %
B	1	20.0 %
C	0	0.0 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 225

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
Very easy	0	0.0 %
Easy	2	40.0 %
Medium Difficulty	0	0.0 %
Difficult	1	20.0 %
Very Difficult	1	20.0 %
Not Applicable, I never have taken a high school physics course	1	20.0 %

Table 226

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
Very easy	0	0.0 %
Easy	1	20.0 %
Medium Difficulty	3	60.0 %
Difficult	1	20.0 %
Very Difficult	0	0.0 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 227

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
Excellent	2	40.0 %
Above Average	3	60.0 %
Average	0	0.0 %
Below Average	0	0.0 %
Poor	0	0.0 %

Table 228

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
Excellent	0	0.0 %
Above Average	4	80.0 %
Average	1	20.0 %
Below Average	0	0.0 %
Poor	0	0.0 %

Table 229

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
Much better	2	40.0 %
Better	3	60.0 %
The Same	0	0.0 %
Worse	0	0.0 %
Much Worse	0	0.0 %

Table 230

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #11 on the Student Survey Form, "Choose which factor is more important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_{AS} = 5)
A person must be born with greater natural mental abilities for physics.	1	20.0 %
A person must spend many hours in personal study of physics.	1	20.0 %
They are of the same importance.	3	60.0 %

Table 231

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	3	60.0 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	2	40.0 %

Table 232

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
A religious student will usually be better at physics than other students.	0	0.0 %
A non-religious student will usually be better at physics than other students.	0	0.0 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	0	0.0 %
A student's religious views have no effect on whether or not that student will be good at physics.	5	100.0 %
None of the above.	0	0.0 %

Table 233

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
They are generally **much better** in physics than students from other countries.	1	20.0 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	2	40.0 %
They are generally **a little worse** in physics than students from other countries.	0	0.0 %
They are generally **much worse** in physics than students from other countries.	2	40.0 %

Table 234

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{AS} = 5)
They are generally **much better** in physics than students from other countries.	0	0.0 %
They are generally **a little better** in physics than students from other countries.	2	40.0 %
They are generally **the same** in physics as students from other countries.	1	20.0 %
They are generally **a little worse** in physics than students from other countries.	2	40.0 %
They are generally **much worse** in physics than students from other countries.	0	0.0 %

Table 235

Survey Results for the Entire Sample of "Asian-Americans" Physics Students (N_{AS} = 5) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_{AS} = 5)
Females naturally have better mental ability for physics than males.	0	0.0 %
Males naturally have better mental ability for physics than females.	1	20.0 %
Females and males have the same mental ability for physics.	4	80.0 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11)

Within the category termed "Other Ethnicities," the researcher has included all student survey respondents who (on the optional question regarding ethnicity on the survey form) chose or listed any ethnicity other than the following ethnicities: African-American, European-American, White, Caucasian, White-Caucasian, or Asian-American. There were several ethnicities represented in the sample labeled as "Other Ethnicities." The following ethnicities were the ones which were included among those in the sample labeled as "Other Ethnicities": (1) European-American *and* Asian-American (both choices were chosen together by one student), (2) European-American *and* Native-American (both choices were chosen together by one student), (3) American (three students), (4) Latin-American (two students), (5) Cajun (one student), (6) African (one student), (7) Indian, not from India (one student), and (8) Lebanese-American (one student). The eight ethnicities shown in the previous numbered list were all grouped together under the category labeled as "Other Ethnicities." One reason the researcher grouped these students together into one category called "Other Ethnicities" was that each of these eight individual ethnicities, if listed separately, would have created extremely small sample sizes with only 1, 2, or 3 students. The total sample size of the "Other Ethnicities" group was still rather small, at just 11 students ($N_{OE} = 11$); but it was nevertheless a larger sample size than would have been possible if the researcher had separated each of these "other ethnicities" into individual sample groups of their own.

Table 236

Gender of the Entire Sample of "Other Ethnicities" Physics Students ($N_{OE} = 11$) who Took the Survey

Gender	Number of Students	% of Sample ($N_{OE} = 11$)
Male	9	81.8 %
Female	2	18.2 %

Table 237

Answers Given by the Entire Sample of "Other Ethnicities" Physics Students ($N_{OE} = 11$) to the Demographic Question on the Student Survey Form, "Did you take physics at a Mississippi high school? (yes or no)"

Answer	Number of Students	% of Sample ($N_{OE} = 11$)
Yes	2	18.2 %
No	9	81.8 %

Survey Results from the Answers Given by the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to the 16 Multiple-Choice Questions on the Student Survey

Table 238

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
Yes	10	90.9 %
No	1	9.1 %
I do not know	0	0.0 %

Table 239

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
0	3	27.3 %
1	5	45.5 %
2	2	18.2 %
3	0	0.0 %
more than 3	0	0.0 %
No Answer was Chosen	1	9.1 %

Table 240

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
A	3	27.3 %
B	3	27.3 %
C	0	0.0 %
D	1	9.1 %
F	0	0.0 %
Not Applicable	3	27.3 %
No Answer was Chosen	1	9.1 %

Table 241

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
0	0	0.0 %
1	0	0.0 %
2	10	90.9 %
3	1	9.1 %
more than 3	0	0.0 %

Table 242

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
A	4	36.4 %
B	4	36.4 %
C	3	27.3 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 243

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
Very easy	2	18.2 %
Easy	0	0.0 %
Medium Difficulty	3	27.3 %
Difficult	2	18.2 %
Very Difficult	0	0.0 %
Not Applicable, I never have taken a high school physics course	3	27.3 %
No Answer was Chosen	1	9.1 %

Table 244

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
Very easy	0	0.0 %
Easy	1	9.1 %
Medium Difficulty	0	0.0 %
Difficult	7	63.6 %
Very Difficult	3	27.3 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 245

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
Excellent	0	0.0 %
Above Average	8	72.7 %
Average	2	18.2 %
Below Average	1	9.1 %
Poor	0	0.0 %

Table 246

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
Excellent	0	0.0 %
Above Average	3	27.3 %
Average	8	72.7 %
Below Average	0	0.0 %
Poor	0	0.0 %

Table 247

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
Much better	2	18.2 %
Better	1	9.1 %
The Same	6	54.6 %
Worse	1	9.1 %
Much Worse	0	0.0 %
No Answer was Chosen	1	9.1 %

Table 248

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #11 on the Student Survey Form, "Choose which factor is more important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_{OE} = 11)
A person must be born with greater natural mental abilities for physics.	0	0.0 %
A person must spend many hours in personal study of physics.	8	72.7 %
They are of the same importance.	3	27.3 %

Table 249

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	1	9.1 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	10	90.9 %

Table 250

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
A religious student will usually be better at physics than other students.	0	0.0 %
A non-religious student will usually be better at physics than other students.	0	0.0 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	1	9.1 %
A student's religious views have no effect on whether or not that student will be good at physics.	9	81.8 %
None of the above.	1	9.1 %

Table 251

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
They are generally **much better** in physics than students from other countries.	1	9.1 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	2	18.2 %
They are generally **a little worse** in physics than students from other countries.	4	36.4 %
They are generally **much worse** in physics than students from other countries.	4	36.4 %

Table 252

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{OE} = 11)
They are generally **much better** in physics than students from other countries.	1	9.1 %
They are generally **a little better** in physics than students from other countries.	1	9.1 %
They are generally **the same** in physics as students from other countries.	5	45.5 %
They are generally **a little worse** in physics than students from other countries.	3	27.3 %
They are generally **much worse** in physics than students from other countries.	1	9.1 %

Table 253

Survey Results for the Entire Sample of "Other Ethnicities" Physics Students (N_{OE} = 11) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_{OE} = 11)
Females naturally have better mental ability for physics than males.	1	9.1 %
Males naturally have better mental ability for physics than females.	3	27.3 %
Females and males have the same mental ability for physics.	6	54.6 %
No Answer was Chosen	1	9.1 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8)

Within the category termed "Chose No Ethnicity," the researcher has included all student survey respondents who did not answer the optional question regarding ethnicity on the survey form. In other words, they left this optional question blank, with no answer circled. Thus, they did not choose any ethnicity at all. Hence, the researcher put these eight students into a group which he originally labeled as "Students Who Chose No Ethnicity"; later, for the sake of brevity, the researcher relabeled this group simply as "Chose No Ethnicity."

Table 254

Gender of the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) who Took the Survey

Gender	Number of Students	% of Sample (N_{CN} = 8)
Male	5	62.5 %
Female	3	37.5 %

Table 255

Answers Given by the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to the Demographic Question on the Student Survey Form, "Did you take physics at a Mississippi high school? (yes or no)"

Answer	Number of Students	% of Sample (N_{CN} = 8)
Yes	2	25.0 %
No	6	75.0 %

Survey Results from the Answers Given by the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to the 16 Multiple-Choice Questions on the Student Survey

Table 256

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
Yes	8	100.0 %
No	0	0.0 %
I do not know	0	0.0 %

Table 257

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
0	4	50.0 %
1	3	37.5 %
2	1	12.5 %
3	0	0.0 %
more than 3	0	0.0 %

Table 258

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
A	3	37.5 %
B	1	12.5 %
C	0	0.0 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	4	50.0 %

Table 259

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
0	0	0.0 %
1	0	0.0 %
2	8	100.0 %
3	0	0.0 %
more than 3	0	0.0 %

Table 260

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
A	5	62.5 %
B	3	37.5 %
C	0	0.0 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 261

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
Very easy	0	0.0 %
Easy	1	12.5 %
Medium Difficulty	2	25.0 %
Difficult	1	12.5 %
Very Difficult	0	0.0 %
Not Applicable, I never have taken a high school physics course	4	50.0 %

Table 262

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
Very easy	0	0.0 %
Easy	0	0.0 %
Medium Difficulty	5	62.5 %
Difficult	3	37.5 %
Very Difficult	0	0.0 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 263

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
Excellent	3	37.5 %
Above Average	4	50.0 %
Average	1	12.5 %
Below Average	0	0.0 %
Poor	0	0.0 %

Table 264

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
Excellent	1	12.5 %
Above Average	2	25.0 %
Average	3	37.5 %
Below Average	1	12.5 %
Poor	0	0.0 %
No Answer was Chosen	1	12.5 %

Table 265

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
Much better	0	0.0 %
Better	3	37.5 %
The Same	4	50.0 %
Worse	0	0.0 %
Much Worse	0	0.0 %
No Answer was Chosen	1	12.5 %

Table 266

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #11 on the Student Survey Form, "Choose which factor is <u>more</u> important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_{CN} = 8)
A person must be born with greater natural mental abilities for physics.	1	12.5 %
A person must spend many hours in personal study of physics.	4	50.0 %
They are of the same importance.	3	37.5 %

Table 267

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	3	37.5 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	4	50.0 %
No Answer was Chosen	1	12.5 %

Table 268

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
A religious student will usually be better at physics than other students.	0	0.0 %
A non-religious student will usually be better at physics than other students.	0	0.0 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	0	0.0 %
A student's religious views have no effect on whether or not that student will be good at physics.	7	87.5 %
None of the above.	1	12.5 %

Table 269

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
They are generally **much better** in physics than students from other countries.	0	0.0 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	2	25.0 %
They are generally **a little worse** in physics than students from other countries.	6	75.0 %
They are generally **much worse** in physics than students from other countries.	0	0.0 %

Table 270

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{CN} = 8)
They are generally **much better** in physics than students from other countries.	0	0.0 %
They are generally **a little better** in physics than students from other countries.	1	12.5 %
They are generally **the same** in physics as students from other countries.	4	50.0 %
They are generally **a little worse** in physics than students from other countries.	2	25.0 %
They are generally **much worse** in physics than students from other countries.	0	0.0 %
No Answer was Chosen	1	12.5 %

Table 271

Survey Results for the Entire Sample of "Chose No Ethnicity" Physics Students (N_{CN} = 8) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_{CN} = 8)
Females naturally have better mental ability for physics than males.	0	0.0 %
Males naturally have better mental ability for physics than females.	5	62.5 %
Females and males have the same mental ability for physics.	3	37.5 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60)

Within the category termed "A-level College Students," the researcher has included all student survey respondents who indicated that their college physics performance could best be described with a grade of "A." In other words, these are the students who, on question #5 of the student survey form, chose the multiple choice answer "(a) A" as the grade that would best describe their college physics performance.

Table 272

Gender of the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) who Took the Survey

Gender	Number of Students	% of Sample (N_{AL} = 60)
Male	38	63.3 %
Female	22	36. 7%

Table 273

Answers Given by the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to the Demographic Question on the Student Survey Form, "Did you take physics at a Mississippi high school? (yes or no)"

Answer	Number of Students	% of Sample (N_{AL} = 60)
Yes	30	50.0 %
No	29	48.3 %
Both Answers (Yes and No) were Given	1	1.7 %

Survey Results from the Answers Given by the Entire Sample of “A-level College Students” Physics Students (N_{AL} = 60) to the 16 Multiple-Choice Questions on the Student Survey

Table 274

Survey Results for the Entire Sample of “A-level College Students” Physics Students (N_{AL} = 60) to Question #1 on the Student Survey Form, “Was a physics course offered at your high school?”

Answer	Number of Students	% of Sample (N_{AL} = 60)
Yes	58	96.7 %
No	2	3.3 %
I do not know	0	0.0 %

Table 275

Survey Results for the Entire Sample of “A-level College Students” Physics Students (N_{AL} = 60) to Question #2 on the Student Survey Form, “How many physics courses did you take in high school?”

Answer	Number of Students	% of Sample (N_{AL} = 60)
0	14	23.3 %
1	33	55.0 %
2	12	20.0 %
3	1	1.7 %
more than 3	0	0.0 %

Table 276

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_{AL} = 60)
A	41	68.3 %
B	4	6.7 %
C	0	0.0 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	15	25.0 %

Table 277

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_{AL} = 60)
0	0	0.0 %
1	7	11.7 %
2	53	88.3 %
3	0	0.0 %
more than 3	0	0.0 %

Table 278

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_{AL} = 60)
A	60	100.0 %
B	0	0.0 %
C	0	0.0 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 279

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_{AL} = 60)
Very easy	6	10.0 %
Easy	5	8.3 %
Medium Difficulty	13	21.7 %
Difficult	15	25.0 %
Very Difficult	7	11.7 %
Not Applicable, I never have taken a high school physics course	13	21.7 %
More than One Answer was Chosen	1	1.7 %

Table 280

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_{AL} = 60)
Very easy	1	1.7 %
Easy	4	6.7 %
Medium Difficulty	33	55.0 %
Difficult	16	26.7 %
Very Difficult	6	10.0 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 281

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_{AL} = 60)
Excellent	25	41.7 %
Above Average	27	45.0 %
Average	8	13.3 %
Below Average	0	0.0 %
Poor	0	0.0 %

Table 282

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_{AL} = 60)
Excellent	8	13.3 %
Above Average	38	63.3 %
Average	12	20.0 %
Below Average	1	1.7 %
Poor	0	0.0 %
More Than One Answer was Chosen	1	1.7 %

Table 283

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_{AL} = 60)
Much better	6	10.0 %
Better	12	20.0 %
The Same	32	53.3 %
Worse	4	6.7 %
Much Worse	0	0.0 %
No Answer was Chosen	6	10.0 %

Table 284

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #11 on the Student Survey Form, "Choose which factor is <u>more</u> important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_{AL} = 60)
A person must be born with greater natural mental abilities for physics.	6	10.0 %
A person must spend many hours in personal study of physics.	23	38.3 %
They are of the same importance.	31	51.7 %

Table 285

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_{AL} = 60)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	25	41.7 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	33	55.0 %
No Answer was Chosen	2	3.3 %

Table 286

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_{AL} = 60)
A religious student will usually be better at physics than other students.	1	1.7 %
A non-religious student will usually be better at physics than other students.	1	1.7 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	2	3.3 %
A student's religious views have no effect on whether or not that student will be good at physics.	52	86.7 %
None of the above.	2	3.3 %
No Answer was Chosen	2	3.3 %

Table 287

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{AL} = 60)
They are generally **much better** in physics than students from other countries.	1	1.7 %
They are generally **a little better** in physics than students from other countries.	1	1.7 %
They are generally **the same** in physics as students from other countries.	14	23.3 %
They are generally **a little worse** in physics than students from other countries.	30	50.0 %
They are generally **much worse** in physics than students from other countries.	11	18.3 %
No Answer was Chosen	3	5.0 %

Table 288

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{AL} = 60)
They are generally **much better** in physics than students from other countries.	3	5.0 %
They are generally **a little better** in physics than students from other countries.	3	5.0 %
They are generally **the same** in physics as students from other countries.	22	36.7 %
They are generally **a little worse** in physics than students from other countries.	29	48.3 %
They are generally **much worse** in physics than students from other countries.	0	0.0 %
No Answer was Chosen	2	3.3 %
More Than One Answer was Chosen	1	1.7 %

Table 289

Survey Results for the Entire Sample of "A-level College Students" Physics Students (N_{AL} = 60) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_{AL} = 60)
Females naturally have better mental ability for physics than males.	2	3.3 %
Males naturally have better mental ability for physics than females.	22	36.7 %
Females and males have the same mental ability for physics.	36	60.0 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39)

Within the category termed "B-level College Students," the researcher has included all student survey respondents who indicated that their college physics performance could best be described with a grade of "B." In other words, these are the students who, on question #5 of the student survey form, chose the multiple choice answer "(b) B" as the grade that would best describe their college physics performance.

Table 290

Gender of the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) who Took the Survey

Gender	Number of Students	% of Sample (N_{BL} = 39)
Male	25	64.1 %
Female	14	35.9 %

Table 291

Answers Given by the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to the Demographic Question on the Student Survey Form, "Did you take physics at a Mississippi high school? (yes or no)"

Answer	Number of Students	% of Sample (N_{BL} = 39)
Yes	10	25.6 %
No	29	74.4 %

Survey Results from the Answers Given by the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to the 16 Multiple-Choice Questions on the Student Survey

Table 292

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
Yes	38	97.4 %
No	1	2.6 %
I do not know	0	0.0 %

Table 293

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
0	14	35.9 %
1	19	48.7 %
2	6	15.4 %
3	0	0.0 %
more than 3	0	0.0 %

Table 294

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
A	15	38.5 %
B	8	20.5 %
C	1	2.6 %
D	1	2.6 %
F	0	0.0 %
Not Applicable	14	35.9 %

Table 295

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
0	0	0.0 %
1	0	0.0 %
2	39	100.0 %
3	0	0.0 %
more than 3	0	0.0 %

Table 296

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
A	0	0.0 %
B	39	100.0 %
C	0	0.0 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 297

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
Very easy	2	5.1 %
Easy	2	5.1 %
Medium Difficulty	13	33.3 %
Difficult	8	20.5 %
Very Difficult	1	2.6 %
Not Applicable, I never have taken a high school physics course	13	33.3 %

Table 298

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
Very easy	0	0.0 %
Easy	1	2.6 %
Medium Difficulty	9	23.1 %
Difficult	25	64.1 %
Very Difficult	4	10.3 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 299

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
Excellent	10	25.6 %
Above Average	26	66.7 %
Average	3	7.7 %
Below Average	0	0.0 %
Poor	0	0.0 %

Table 300

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
Excellent	0	0.0 %
Above Average	10	25.6 %
Average	27	69.2 %
Below Average	1	2.6 %
Poor	0	0.0 %
No Answer was Chosen	1	2.6 %

Table 301

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
Much better	6	15.4 %
Better	5	12.8 %
The Same	23	59.0 %
Worse	3	7.7 %
Much Worse	1	2.6 %
No Answer was Chosen	1	2.6 %

Table 302

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #11 on the Student Survey Form, "Choose which factor is more important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_{BL} = 39)
A person must be born with greater natural mental abilities for physics.	3	7.7 %
A person must spend many hours in personal study of physics.	19	48.7 %
They are of the same importance.	17	43.6 %

Table 303

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	17	43.6 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	22	56.4 %

Table 304

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
A religious student will usually be better at physics than other students.	1	2.6 %
A non-religious student will usually be better at physics than other students.	5	12.8 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	0	0.0 %
A student's religious views have no effect on whether or not that student will be good at physics.	33	84.6 %
None of the above.	0	0.0 %

Table 305

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
They are generally **much better** in physics than students from other countries.	2	5.1 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	15	38.5 %
They are generally **a little worse** in physics than students from other countries.	18	46.2 %
They are generally **much worse** in physics than students from other countries.	3	7.7 %
No Answer was Chosen	1	2.6 %

Table 306

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{BL} = 39)
They are generally **much better** in physics than students from other countries.	1	2.6 %
They are generally **a little better** in physics than students from other countries.	5	12.8 %
They are generally **the same** in physics as students from other countries.	17	43.6 %
They are generally **a little worse** in physics than students from other countries.	15	38.5 %
They are generally **much worse** in physics than students from other countries.	0	0.0 %
No Answer was Chosen	1	2.6 %

Table 307

Survey Results for the Entire Sample of "B-level College Students" Physics Students (N_{BL} = 39) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_{BL} = 39)
Females naturally have better mental ability for physics than males.	0	0.0 %
Males naturally have better mental ability for physics than females.	16	41.0 %
Females and males have the same mental ability for physics.	22	56.4 %
No Answer was Chosen	1	2.6 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14)

Within the category termed "C-level or Below College Students," the researcher has included all student survey respondents who indicated that their college physics performance could best be described with a grade of "C" (or in two cases, "D"). In other words, these are the students who, on question #5 of the student survey form, chose the multiple choice answer "(c) C" (or, in two cases, "(d) D") as the grade that would best describe their college physics performance. There were 12 students who chose "(c) C," and there were 2 students who chose "(d) D" as the grade that would best describe their college physics performance. There were no students who chose “(f) F,” and there were no students who chose “(g) Not Applicable” as the grade that would best describe their college physics performance. Thus, the 14 students in this sample are C-level and D-level students, with the large majority (12 of 14) of them classifying themselves as C-level students in their college physics course.

Table 308

Gender of the Entire Sample of “C-level or Below College Students” Physics Students (N_{CL} = 14) who Took the Survey

Gender	Number of Students	% of Sample (N_{CL} = 14)
Male	9	64.3 %
Female	5	35.7 %

Table 309

Answers Given by the Entire Sample of “C-level or Below College Students” Physics Students (N_{CL} = 14) to the Demographic Question on the Student Survey Form, “Did you take physics at a Mississippi high school? (yes or no)”

Answer	Number of Students	% of Sample (N_{CL} = 14)
Yes	4	28.6 %
No	10	71.4 %

Survey Results from the Answers Given by the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to the 16 Multiple-Choice Questions on the Student Survey

Table 310

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
Yes	12	85.7 %
No	1	7.1 %
I do not know	1	7.1 %

Table 311

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
0	4	28.6 %
1	6	42.9 %
2	3	21.4 %
3	0	0.0 %
more than 3	0	0.0 %
No Answer was Chosen	1	7.1 %

Table 312

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
A	2	14.3 %
B	6	42.9 %
C	0	0.0 %
D	1	7.1 %
F	0	0.0 %
Not Applicable	4	28.6 %
No Answer was Chosen	1	7.1 %

Table 313

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
0	0	0.0 %
1	0	0.0 %
2	13	92.9 %
3	1	7.1 %
more than 3	0	0.0 %

Table 314

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
A	0	0.0 %
B	0	0.0 %
C	12	85.7 %
D	2	14.3 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 315

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
Very easy	1	7.1 %
Easy	1	7.1 %
Medium Difficulty	3	21.4 %
Difficult	4	28.6 %
Very Difficult	0	0.0 %
Not Applicable, I never have taken a high school physics course	4	28.6 %
No Answer was Chosen	1	7.1 %

Table 316

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
Very easy	0	0.0 %
Easy	0	0.0 %
Medium Difficulty	1	7.1 %
Difficult	7	50.0 %
Very Difficult	6	42.9 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 317

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
Excellent	3	21.4 %
Above Average	4	28.6 %
Average	6	42.9 %
Below Average	1	7.1 %
Poor	0	0.0 %

Table 318

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
Excellent	1	7.1 %
Above Average	1	7.1 %
Average	8	57.1 %
Below Average	3	21.4 %
Poor	1	7.1 %

Table 319

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
Much better	1	7.1 %
Better	2	14.3 %
The Same	5	35.7 %
Worse	5	35.7 %
Much Worse	0	0.0 %
No Answer was Chosen	1	7.1 %

Table 320

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #11 on the Student Survey Form, "Choose which factor is more important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_{CL} = 14)
A person must be born with greater natural mental abilities for physics.	1	7.1 %
A person must spend many hours in personal study of physics.	10	71.4 %
They are of the same importance.	3	21.4 %

Table 321

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	5	35.7 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	9	64.3 %

Table 322

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
A religious student will usually be better at physics than other students.	0	0.0 %
A non-religious student will usually be better at physics than other students.	0	0.0 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	2	14.3 %
A student's religious views have no effect on whether or not that student will be good at physics.	10	71.4 %
None of the above.	2	14.3 %

Table 323

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
They are generally **much better** in physics than students from other countries.	1	7.1 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	5	35.7 %
They are generally **a little worse** in physics than students from other countries.	4	28.6 %
They are generally **much worse** in physics than students from other countries.	4	28.6 %

Table 324

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_{CL} = 14)
They are generally **much better** in physics than students from other countries.	1	7.1 %
They are generally **a little better** in physics than students from other countries.	1	7.1 %
They are generally **the same** in physics as students from other countries.	7	50.0 %
They are generally **a little worse** in physics than students from other countries.	3	21.4 %
They are generally **much worse** in physics than students from other countries.	2	14.3 %

Table 325

Survey Results for the Entire Sample of "C-level or Below College Students" Physics Students (N_{CL} = 14) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_{CL} = 14)
Females naturally have better mental ability for physics than males.	0	0.0 %
Males naturally have better mental ability for physics than females.	7	50.0 %
Females and males have the same mental ability for physics.	6	42.9 %
No Answer was Chosen	1	7.1 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of "Engineering Physics" Students (N_e = 64)

Within the category termed "Engineering Physics" students, the researcher has included all student survey respondents who were present (and who turned in completed survey forms—or mostly completed forms since a few students left some questions blank) in the Engineering Physics II labs when the researcher gave the surveys. The researcher gave surveys to three Engineering Physics II labs and to two Pre-med Physics II labs. This sample, labeled "Engineering Physics," includes the 64 engineering physics students who were present (and who completed, or mostly completed, the survey form) in one of the three Engineering Physics II labs to which the researcher gave surveys. Any students who did not turn in a completed survey form (or a mostly completed survey form) were not counted in this sample.

Table 326

Gender of the Entire Sample of "Engineering Physics" Students (N_e = 64) who Took the Survey

Gender	Number of Students	% of Sample (N_e = 64)
Male	46	71.9 %
Female	18	28.1 %

Table 327

Answers Given by the Entire Sample of "Engineering Physics" Students (N_e = 64) to the Demographic Question on the Student Survey Form, "Did you take physics at a Mississippi high school? (yes or no)"

Answer	Number of Students	% of Sample (N_e = 64)
Yes	24	37.5 %
No	40	62.5 %

Survey Results from the Answers Given by the Entire Sample of "Engineering Physics" Students (N_e = 64) to the 16 Multiple-Choice Questions on the Student Survey

Table 328

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample (N_e = 64)
Yes	62	96.9 %
No	2	3.1 %
I do not know	0	0.0 %

Table 329

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample (N_e = 64)
0	13	20.3 %
1	36	56.3 %
2	15	23.4 %
3	0	0.0 %
more than 3	0	0.0 %

Table 330

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_e = 64)
A	35	54.7 %
B	15	23.4 %
C	1	1.6 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	13	20.3 %

Table 331

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_e = 64)
0	0	0.0 %
1	1	1.6 %
2	63	98.4 %
3	0	0.0 %
more than 3	0	0.0 %

Table 332

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_e = 64)
A	27	42.2 %
B	27	42.2 %
C	8	12.5 %
D	2	3.1 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 333

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_e = 64)
Very easy	3	4.7 %
Easy	6	9.4 %
Medium Difficulty	19	29.7 %
Difficult	19	29.7 %
Very Difficult	4	6.3 %
Not Applicable, I never have taken a high school physics course	13	20.3 %

Table 334

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_e = 64)
Very easy	0	0.0 %
Easy	3	4.7 %
Medium Difficulty	21	32.8 %
Difficult	27	42.2 %
Very Difficult	13	20.3 %
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 335

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_e = 64)
Excellent	18	28.1 %
Above Average	36	56.3 %
Average	10	15.6 %
Below Average	0	0.0 %
Poor	0	0.0 %

Table 336

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_e = 64)
Excellent	1	1.6 %
Above Average	27	42.2 %
Average	29	45.3 %
Below Average	5	7.8 %
Poor	1	1.6 %
No Answer was Chosen	1	1.6 %

Table 337

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_e = 64)
Much better	10	15.6 %
Better	9	14.1 %
The Same	33	51.6 %
Worse	10	15.6 %
Much Worse	0	0.0 %
No Answer was Chosen	2	3.1 %

Table 338

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #11 on the Student Survey Form, "Choose which factor is <u>more</u> important in order for someone to become a good physicist."

Answer	Number of Students	% of Sample (N_e = 64)
A person must be born with greater natural mental abilities for physics.	3	4.7 %
A person must spend many hours in personal study of physics.	30	46.9 %
They are of the same importance.	31	48.4 %

Table 339

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_e = 64)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	24	37.5 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	40	62.5 %

Table 340

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_e = 64)
A religious student will usually be better at physics than other students.	1	1.6 %
A non-religious student will usually be better at physics than other students.	5	7.8 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	2	3.1 %
A student's religious views have no effect on whether or not that student will be good at physics.	54	84.4 %
None of the above.	2	3.1 %

Table 341

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_e = 64)
They are generally **much better** in physics than students from other countries.	3	4.7 %
They are generally **a little better** in physics than students from other countries.	0	0.0 %
They are generally **the same** in physics as students from other countries.	20	31.3 %
They are generally **a little worse** in physics than students from other countries.	29	45.3 %
They are generally **much worse** in physics than students from other countries.	11	17.2 %
No Answer was Chosen	1	1.6 %

Table 342

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_e = 64)
They are generally **much better** in physics than students from other countries.	2	3.1 %
They are generally **a little better** in physics than students from other countries.	7	10.9 %
They are generally **the same** in physics as students from other countries.	32	50.0 %
They are generally **a little worse** in physics than students from other countries.	22	34.4 %
They are generally **much worse** in physics than students from other countries.	1	1.6 %

Table 343

Survey Results for the Entire Sample of "Engineering Physics" Students (N_e = 64) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_e = 64)
Females naturally have better mental ability for physics than males.	1	1.6 %
Males naturally have better mental ability for physics than females.	27	42.2 %
Females and males have the same mental ability for physics.	36	56.3 %

Demographic Statistics (Obtained from the Student Surveys) for the Entire Sample of "Pre-med Physics" Students (N_p = 49)

Within the category termed "Pre-med Physics" students, the researcher has included all student survey respondents who were present (and who turned in completed survey forms—or mostly completed forms since a few students left some questions blank) in the General Physics II labs when the researcher gave the surveys. The researcher gave surveys to two General Physics II labs (also known as Pre-med Physics II labs) and to three Engineering Physics II labs. This sample, labeled "Pre-med Physics," includes the 49 general (pre-med) physics students who were present (and who completed, or mostly completed, the survey form) in one of the two General Physics II labs to which the researcher gave surveys. Any students who did not turn in a completed survey form (or a mostly completed survey form) were not counted in this sample.

Table 344

Gender of the Entire Sample of "Pre-med Physics" Students (N_p = 49) who Took the Survey

Gender	Number of Students	% of Sample (N_p = 49)
Male	26	53.1 %
Female	23	46.9 %

Table 345

Answers Given by the Entire Sample of "Pre-med Physics" Students (N_p = 49) to the Demographic Question on the Student Survey Form, "Did you take physics at a Mississippi high school? (yes or no)"

Answer	Number of Students	% of Sample (N_p = 49)
Yes	20	40.8 %
No	28	57.1 %
Chose Both Answers	1	2.0 %

Survey Results from the Answers Given by the Entire Sample of "Pre-med Physics" Students ($N_p = 49$) to the 16 Multiple-Choice Questions on the Student Survey

Table 346

Survey Results for the Entire Sample of "Pre-med Physics" Students ($N_p = 49$) to Question #1 on the Student Survey Form, "Was a physics course offered at your high school?"

Answer	Number of Students	% of Sample ($N_p = 49$)
Yes	46	93.9 %
No	2	4.1 %
I do not know	1	2.0 %

Table 347

Survey Results for the Entire Sample of "Pre-med Physics" Students ($N_p = 49$) to Question #2 on the Student Survey Form, "How many physics courses did you take in high school?"

Answer	Number of Students	% of Sample ($N_p = 49$)
0	19	38.8 %
1	22	44.9 %
2	6	12.2 %
3	1	2.0 %
more than 3	0	0.0 %
No Answer was Chosen	1	2.0 %

Table 348

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #3 on the Student Survey Form, "Choose one grade that would best be used to describe your high school physics performance?"

Answer	Number of Students	% of Sample (N_p = 49)
A	23	46.9 %
B	3	6.1 %
C	0	0.0 %
D	2	4.1 %
F	0	0.0 %
Not Applicable	20	40.8 %
No Answer was Chosen	1	2.0 %

Table 349

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #4 on the Student Survey Form, "How many physics courses have you taken in college?"

Answer	Number of Students	% of Sample (N_p = 49)
0	0	0.0 %
1	6	12.2 %
2	42	85.7 %
3	1	2.0 %
more than 3	0	0.0 %

Table 350

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #5 on the Student Survey Form, "Choose one grade that would best be used to describe your college physics performance?"

Answer	Number of Students	% of Sample (N_p = 49)
A	33	67.4 %
B	12	24.5 %
C	4	8.2 %
D	0	0.0 %
F	0	0.0 %
Not Applicable	0	0.0 %

Table 351

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #6 on the Student Survey Form, "How difficult were your high school physics courses?"

Answer	Number of Students	% of Sample (N_p = 49)
Very easy	6	12.2 %
Easy	2	4.1 %
Medium Difficulty	10	20.4 %
Difficult	8	16.3 %
Very Difficult	4	8.2%
Not Applicable, I never have taken a high school physics course	17	34.7 %
More Than One Answer was Chosen	1	2.0 %
No Answer was Chosen	1	2.0 %

Table 352

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #7 on the Student Survey Form, "How difficult were your college physics courses?"

Answer	Number of Students	% of Sample (N_p = 49)
Very easy	1	2.0 %
Easy	2	4.1 %
Medium Difficulty	22	44.9 %
Difficult	21	42.9 %
Very Difficult	3	6.1%
Not Applicable, I never have taken a college physics course	0	0.0 %

Table 353

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #8 on the Student Survey Form, "How good are you at math?"

Answer	Number of Students	% of Sample (N_p = 49)
Excellent	20	40.8 %
Above Average	21	42.9 %
Average	7	14.3 %
Below Average	1	2.0 %
Poor	0	0.0 %

Table 354

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #9 on the Student Survey Form, "How good are you at physics?"

Answer	Number of Students	% of Sample (N_p = 49)
Excellent	8	16.3 %
Above Average	22	44.9 %
Average	18	36.7 %
Below Average	0	0.0 %
Poor	0	0.0 %
Two Answers were Chosen	1	2.0 %

Table 355

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #10 on the Student Survey Form, "Are people from your ethnicity group good at physics compared to other groups?"

Answer	Number of Students	% of Sample (N_p = 49)
Much better	3	6.1 %
Better	10	20.4 %
The Same	27	55.1 %
Worse	2	4.1 %
Much Worse	1	2.0 %
No Answer was Chosen	6	12.2 %

Table 356

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #11 on the Student Survey Form, "Choose which factor is <u>more</u> *important in order for someone to become a good physicist."*

Answer	Number of Students	% of Sample (N_p = 49)
A person must be born with greater natural mental abilities for physics.	7	14.3 %
A person must spend many hours in personal study of physics.	22	44.9 %
They are of the same importance.	20	40.8 %

Table 357

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #12 on the Student Survey Form, "Which statement best represents your opinion?"

Answer	Number of Students	% of Sample (N_p = 49)
The majority of people **are** born with the necessary mental capacity to become physicists when they reach adulthood.	23	46.9 %
The majority of people **are not** born with the necessary mental capacity to become physicists when they reach adulthood.	24	49.0 %
No Answer was Chosen	2	4.1 %

Table 358

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #13 on the Student Survey Form, "Which of the following best represents your beliefs concerning physics performance?"

Answer	Number of Students	% of Sample (N_p = 49)
A religious student will usually be better at physics than other students.	1	2.0 %
A non-religious student will usually be better at physics than other students.	1	2.0 %
A student who is neither religious nor unreligious will usually be better at physics than other people.	2	4.1 %
A student's religious views have no effect on whether or not that student will be good at physics.	41	83.7 %
None of the above.	2	4.1 %
No Answer was Chosen	2	4.1 %

Table 359

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #14 on the Student Survey Form, "Are Mississippi students good at physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_p = 49)
They are generally **much better** in physics than students from other countries.	1	2.0 %
They are generally **a little better** in physics than students from other countries.	1	2.0 %
They are generally **the same** in physics as students from other countries.	14	28.6 %
They are generally **a little worse** in physics than students from other countries.	23	46.9 %
They are generally **much worse** in physics than students from other countries.	7	14.3 %
No Answer was Chosen	3	6.1 %

Table 360

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #15 on the Student Survey Form, "Are American students good in physics when compared to students from other countries?"

Answer	Number of Students	% of Sample (N_p = 49)
They are generally **much better** in physics than students from other countries.	3	6.1 %
They are generally **a little better** in physics than students from other countries.	2	4.1 %
They are generally **the same** in physics as students from other countries.	14	28.6 %
They are generally **a little worse** in physics than students from other countries.	25	51.0 %
They are generally **much worse** in physics than students from other countries.	1	2.0 %
No Answer was Chosen	3	6.1 %
Two Answers were Chosen	1	2.0 %

Table 361

Survey Results for the Entire Sample of "Pre-med Physics" Students (N_p = 49) to Question #16 on the Student Survey Form, "Choose the answer that best describes your opinion of how physics ability is affected by gender."

Answer	Number of Students	% of Sample (N_p = 49)
Females naturally have better mental ability for physics than males.	1	2.0 %
Males naturally have better mental ability for physics than females.	18	36.7 %
Females and males have the same mental ability for physics.	28	57.1 %
No Answer was Chosen	2	4.1 %

Students' Written Responses to Short-Answer Questions from the Student Survey Forms

<u>**Question # 17**</u>**: Do you enjoy the subject of physics? Explain.**

Student #1: I do somewhat. I enjoy some concepts but not others.

Student #2: No, because it requires more than just the general equations of regular math. It requires making substitutions with more than one equation and requires a lot of memorization and thinking in a limited amount of time.

Student #3: [No answer given.]

Student #4: It's interesting—but not what I want to do with my life.

Student #5: Yes. It is fun.

Student #6: Yes. I like math.

Student #7: Yes, because it has a great deal of math.

Student #8: Yes, understanding the reason things in nature act the way they do is fascinating.

Student #9: I did in high school, but the pace of classes in physics in college is too fast and not enjoyable.

Student #10: No, too in depth.

Student #11: Yes; it is applicable to everyday life for problem solving. I enjoy solving problems.

Student #12: I enjoy the logical aspects of it. However, it really does not apply to my major.

Student #13: Yes. I like how there is a lot of math involved and I enjoy math.

Student #14: I enjoy once I understand the concepts thoroughly.

Student #15: Kinda, I mean I would never do it for fun.

Student #16: No, it is too much math to be used in the real world in my opinion.

Student #17: Yes, the subject is math-based and logical.

Student #18: Yes, I enjoy math and the problem solving aspects of physics.

Student #19: Yes I did. I feel that taking the 2 physics classes have improved my problem solving abilities.

Student #20: Yes, it is easy for me to picture the phenomena that we discuss.

Student #21: I absolutely abhor physics. I love math, but for some reason, physics is terrible. I'm not great at understanding the concepts.

Student #22: Yes, I enjoyed learning what causes many of the everyday things we experience to happen.

Student #23: I don't mind physics. Once our teacher actually does examples with us so it makes sense.

Student #24: I do because it explains many of the phenomenon I experience everyday.

Student #25: I think certain aspects are interesting.

Student #26: No, honestly just too much to grasp when it isn't that relevant to my field.

Student #27: Yes, it allows me to explore all of the different aspects of life, respectively.

Student #28:   No, physics has never caught my attention because it's hard for me to fully understand.

Student #29: Yes, I like to understand how everything works in life.

Student #30: No. The concept is fascinating, however, manipulating meaningless numbers is not fun.

Student #31: Not in particular, but I enjoy learning how physics relates to daily life.

Student #32: I enjoy math; however, not as much physics. It is fairly difficult.

Student #33: Some, the fact that [it] is very difficult makes it hard to enjoy.

Student #34: I do not. Because it is very hard to understand.

Student #35: Depends on the topic.

Student #36: Not really. Even though I'm pretty good at physics, it doesn't really interest me.

Student #37: I liked it in high school, but I'm not sure I can say the same now that I'm in college.

Student #38: I find physics to be challenging simply because it doesn't really interest me.

Student #39: Yes, I enjoy math and figuring out advanced problems.

Student #40: Yes, it is a very interesting subject and explains many phenomenas.

Student #41: Yes, it helps to explain why everyday things work.

Student #42: I like the parts where I can picture the problem in my head (non-theoretical).

Student #43: Yes, physics is the study of everything around us. It is interesting to see how things work.

Student #44: Indifferent.

Student #45: No, it's hard.

Student #46: Yes, I think physics is interesting and applicable to everyday life.

Student #47: Not really. I don't feel it will be used in my field of study/job.

Student #48: Yes, it is very interesting.

Student #49: Sometimes. I enjoy mechanics, not what we have studied in 212 [Calculus-based Physics II].

Student #50: Yes. Understanding how things work has always been an interest of mine.

Student #51: Yes, I have ever since I was 8 years old. My dad introduced me to the subject.

Student #52: No; too hard to understand.

Student #53: Yes. It makes me think; using formulas, laws, and theories to solve problems.

Student #54: Yes. The concepts and the way I can apply them to my life and the world around me is what keeps me interested.

Student #55: I do because it makes sense and explains a lot about surroundings.

Student #56: Yes, I do. I enjoy seeing how things work, and why things behave the way they do.

Student #57: Yes. It is fun to learn about the various concepts.

Student #58: Somewhat. It is very difficult to grasp but it is interesting.

Student #59: I do not enjoy physics because I am not good at it. I feel every problem is different and it is hard to practice the problems to get better.

Student #60: To a certain extent. I would need many hours of study to enjoy it daily.

Student #61: I find it interesting but it is a struggle to learn.

Student #62: Yes. It explains the world around us.

Student #63: I do not enjoy the subject of physics because there are a lot of abstract problems involved.

Student #64: Yes. It is thought provoking and allows one to see the world in a different light.

Student #65: Yes, I have an aptitude for the subject matter and can apply it to life.

Student #66: No, I do not think in a way that allows me to grasp the concept of physics.

Student #67: Yes, I like challenges.

Student #68: Yes; the labs are fun, and the topics are interesting.

Student #69: Yes, because I enjoy classes using mathematics.

Student #70: Yes because it gives you real life problems. You can take numbers and give it actual meaning.

Student #71: Yes, it is interesting how you can figure out different things in your daily life by using physics.

Student #72: Yes, it’s interesting learning how things react and why they behave in a certain manner.

Student #73: Yes, it makes sense and there are few gray areas when it comes to testing.

Student #74: No, not at all.

Student #75: Certain topics interest me but some don't.

Student #76: Yes, the concepts of currents are very interesting.

Student #77: [No answer given.]

Student #78: Yes, it is applicable to daily life.

Student #79: No, physics is numbers and digits. Though some aspects, astronomical physics, may be interesting, general physics is of minimal interest.

Student #80: I enjoy learning how things work but I despise doing the math to see why.

Student #81: Yes, it involves much critical thinking.

Student #82: I do not.

Student #83: [No answer given.]

Student #84: No.

Student #85: I find the class easy, but I would not want to have it as a major.

Student #86: I've enjoyed physics this summer because I had a good teacher, but it is not something I would like to study forever.

Student #87: Yes, it teaches complex problem solving skills and rational thought.

Student #88: To a degree, if the subject being studied is interesting to me.

Student #89: Depends on what it is. I liked learning about vectors and the circuit because I had a basic understanding from high school.

Student #90: So/so.

Student #91: Yes, I enjoy learning about how stuff works.

Student #92: I'm warming into it; I understand a good bit of it now, and I find some of it interesting.

Student #93: Yes, it gives meaning to everything going on in life. (Ex. force, space).

Student #94: Yes. Physics is more conceptual than other sciences. It's not memorizing facts, it's achieving a deeper understanding.

Student #95: No.

Student #96: Yes and no, I enjoy the concepts, but the problems are sometimes more irksome than other subjects.

Student #97: I enjoy the subject, however I do not want to pursue a physics major.

Student #98: The lectures, yes. The labs, no.

Student #99: Not really, the theory is interesting but the math is tedious.

Student #100: Yes, I think it is very interesting to learn about what all goes into simple everyday things.

Student #101: Slightly, I enjoy working out calculations but am not a fan of all the electrical work involved.

Student #102: Yes. I enjoy solving problems and seeing those solutions have observable effects.

Student #103: No, [however?] formulas and theories are useful for application problems in engineering.

Student #104: I enjoy physics but I prefer other areas more. I have a huge fascination of relativity.

Student #105: Yes, the subject matter and applications are interesting.

Student #106: It's not my favorite subject, but I don't mind it since it is heavily math based.

Student #107: Yes. I enjoy it. It's much more finite than other courses, meaning if you know it, you know it.

Student #108: Not really, I would like to take other courses but need to take physics.

Student #109: If it is taught by someone who realizes that physics is difficult to understand, yes. However, many professors assume students know a great deal about physics.

Student #110: No! The physics department here is shoddily run.

Student #111: No. The application of formulas is just explained as fact. There is not a proof for everything.

Student #112: Yes. It allows me to see how the world works at a deeper level.

Student #113: Kind of, I like the ideas and theories, not actual doing.

Question # 18: Why did you choose not to major in physics? (Note: If this question does not apply to you, please skip this question.)

Student #1: I am not a physics major because I am not that interested in it. I do enjoy the physics that is included in physiology of the body.

Student #2: I took AP Calculus in high school, and when we covered a bit of physics in that class, it left me confused.

Student #3: [No answer given.]

Student #4: I didn't want to be in the sciences.

Student #5: It is not *that* fun. [The researcher added the emphasis, because the student previously answered Question #17 with "Yes. It is fun." in response to whether or not he or she enjoyed the subject of physics.]

Student #6: No specific title when graduate.

Student #7: I don't want a career in physics.

Student #8: I like biochem more.

Student #9: I want to be a Doctor; physics is just required for medical school.

Student #10: I like working with people and the human body.

Student #11: I did not major in physics because I felt biology was more important for a career in medicine. I wish I would have known how much I would love it; I would have chosen physics.

Student #12: I enjoy more of the math/logical parts of physics than the actual physics theory. Also, my passion for medicine is much greater than my affinity for math.

Student #13: While I enjoy physics, I do not enjoy it enough for it to be my major.

Student #14: I want to be a psychiatrist, so I majored in psychology and am only taking this course to prepare for the MCAT.

Student #15: [Answer not applicable to question.]

Student #16: Income is not high enough in this field for the amount of effort needed to be successful.

Student #17: I've always had a compassion for pharmacy.

Student #18: [Not applicable since this student did major in physics.]

Student #19: I didn't have an extreme interest in taking lots of upper level physics classes even though I found the basic "entry level" physics interesting.

Student #20: I enjoy biology more than I enjoy physics. My career path does not involve much physics.

Student #21: Because I don't like physics.

Student #22: I had more of an interest in the major I chose.

Student #23: I have no interest in it.

Student #24: I found pharmacy more interesting.

Student #25: I cared more to be a civil engineer.

Student #26: Seems like it requires an extra amount of study to maintain good grades.

Student #27: Mechanical engineering is a better all-the-round subject for me.

Student #28: I already had a different major in mind, and I knew I didn't want to have a job that was science related.

Student #29: Because I want to build stuff.

Student #30: I want to be an engineer.

Student #31: I don't have the patience for it.

Student #32: I would never be a physics major. I am deading [dreading?] the 2 physics classes I have to take now.

Student #33: It's really difficult.

Student #34: Because I would not make it too far.

Student #35: Prefer application to theory.

Student #36: I get good grades in my physics classes, but physics doesn't particularly interest me more than other subjects, so I don't think I would ever consider it as a major.

Student #37: Wasn't interested in doing so, I can only take so much physics at a time.

Student #38: It does not interest me.

Student #39: I want to work in an outdoor environment, not a physics lab.

Student #40: Family business needs engineers.

Student #41: The idea I have for the work physics majors do is too research based.

Student #42: I don't enjoy theoretical physics.

Student #43: Physics is not my main interest.

Student #44: [No answer given.]

Student #45: It's hard.

Student #46: I think my engineering major will be more useful to get a job.

Student #47: The jobs associated with it don't interest me.

Student #48: Because I'd prefer a higher paying job.

Student #49: It is too difficult for me / I do not have the patience nor desire to major in it.

Student #50: I was more interested in mechanical engineer.

Student #51: In order to get my feet in the door of a good career in engineering, then I shall pursue my physics major.

Student #52: It doesn't seem like something I would be interested in.

Student #53: I did not choose physics as a major because I really love construction. That is why I chose civil engineering.

Student #54: It didn't pique my interest as much as engineering.

Student #55: I like engineering more.

Student #56: I didn't really think about it. I had already decided to major in chemical engineering.

Student #57: Because it is not my main interest.

Student #58: I plan to be a surgeon. Chemical engineering is my back up degree if I do not do pre-med.

Student #59: I chose not to major in physics because it is not in my area of interest.

Student #60: My interest is not that high in physics.

Student #61: I would go insane.

Student #62: [Not applicable since this student did major in physics.]

Student #63: I did not want to major in physics because I was not interested.

Student #64: Physics is not my passion, but I do enjoy it. Since I knew I was pre-med, I chose a major I enjoyed and would provide me with information I don't receive in med school.

Student #65: [Not applicable since this student did major in physics.]

Student #66:   I cannot see myself spending the rest of my life doing physics, and I want to be in a medical field.

Student #67: I want a good GPA, and I don't like advanced math. Bio is more applicable to my future in med school.

Student #68: I had never taken a physics class, and I enjoy music.

Student #69: I decided Biology and Chemistry would be a better fit because I want to go to Med School.

Student #70: Did not really know much about it.

Student #71: Physics although is very interesting, it is difficult.

Student #72: I did not enjoy high school physics.

Student #73: No a big fan of math which is an integral part of physics.

Student #74: I have no desire to even think about physics.

Student #75: Physics was not my interest. The human body and how it moves is.

Student #76: I personally like medicine more.

Student #77: [No answer given.]

Student #78: I enjoy biology and psychology more.

Student #79: I find bodily functions and reactions much more interesting than physics.

Student #80: Because I prefer learning how the human body functions rather than objects.

Student #81: Until this year, I had little to no experience with the subject of physics.

Student #82: I do not enjoy it.

Student #83: [No answer given.]

Student #84: (1) I had a bad experience in Physics I. (2) I've always wanted to be a pharmacist.

Student #85: I find chemistry and biology to be much more interesting fields.

Student #86: I have never considered physics as a major because I have never been great in math.

Student #87: [Not applicable since this student did major in physics.]

Student #88: Because I like the outdoors and GE [Geological Engineering] allows me to enjoy working outside.

Student #89: I had to take this course. I like chemistry and math better.

Student #90: [Answer not applicable to question.]

Student #91: Because I was [not?] the best at it and find it hard to grasp.

Student #92: My calling is more in chemistry than in physics.

Student #93: Not that interested.

Student #94: I prefer engineering because I can see the results of my work on a large scale. Unless you make some new breakthrough in physics, you aren't really doing anything that hasn't been done before.

Student #95: I do not like physics.

Student #96: I really enjoy chemistry, so I chose that direction.

Student #97: Chemical engineering made more sense and in my opinion, more enjoyable.

Student #98: Mechanical engineering offers more job opportunities that I would be interested in.

Student #99: I want to go to med-school and biochem is more developed towards that.

Student #100: There were other fields that interested me more.

Student #101: Because I believe I am a better student in other courses and am not a great physics student, but decent.

Student #102: As a member of the military, my scholarship only applies to engineering majors.

Student #103: Engineers are more valuable than physicists and one can do more with engineering than physics.

Student #104: I like to have a general understanding in all areas of science and apply them in real world applications.

Student #105: I chose to minor in Physics rather than major to better prepare for my intended career.

Student #106: I wanted to major in something else. Physics in the upper levels seems complicated.

Student #107: Engineering, while involving physics, opens up a wider range of job capabilities.

Student #108: I like computer science better because I find it more interesting.

Student #109: It didn't suit my future plans.

Student #110: It has absolutely no interest to me.

Student #111: Math is much easier for me, and physics is simply math applied to another set of rules. I chose the purest subject.

Student #112: For pre-med purposes, chemistry gives me classes more relevant to the graduate courses I hope to take.

Student #113: 'Cause what job would I have? I do not want to teach.

<u>Question # 19</u>: Why did you choose to major in physics? (Note: If this question does not apply to you, please skip this question.)

Student #18: I chose to major in physics because I enjoy math and problem solving. I think this science background will help me in my pursuit of Medical school.

Student #62: You can do anything with a physics degree. It's also going to set me apart from other engineering students when I apply to grad school.

Student #65: Physics represents a method of thinking outside of the box and new problem solving; perfect for the future of medicine.

Student #87: It can lead to a career in engineering, medicine, and many other careers.

<u>Question # 20</u>: Have you chosen a major? If so, why did you choose your particular major?

Student #1: Exercise Science. I enjoy learning about how the body operates.

Student #2: Yes. I chose my major because I like math and science. I felt that pharmacy was interesting and that I could do that as a career.

Student #3: [No answer given.]

Student #4: I am good at communicating.

Student #5: Yes, I love medicine.

Student #6: Yes, title when graduate.

Student #7: I tore my ACL and got interested in PT, and I like working with people.

Student #8: [No answer given].

Student #9: I want to be a Doctor; physics is just required for medical school. [The student used the same answer for both Question # 18 and Question #20.]

Student #10: Yes. I like working with people and the human body. [For the second part of the answer, the student used the same answer as the one from Question # 18 .]

Student #11: Biology; I thought it would be most relative to medicine.

Student #12: Pharmacy; I love science and I want to help people.

Student #13: Biochemistry is my major. I choose it because I felt it was very interesting and challenging.

Student #14: I want to be a psychiatrist, so I majored in psychology and am only taking this course to prepare for the MCAT. [The student used the same answer for both Question # 18 and Question #20.]

Student #15: [Answer not applicable to question.]

Student #16: Pre-Med. I want to be a geriatric specialist and the science is interesting to me.

Student #17: Yes, it will allow me to get the job I want.

Student #18: [No answer was given since the student was a physics major, and thus had already answered this question in reply to Question #19.]

Student #19: Yes, biochemistry. I find science courses challenging and interesting.

Student #20: Yes, I have chosen biology as my major because I have decided to go into the health profession.

Student #21: Yes, Biology and Spanish. I enjoy both of these subjects thoroughly.

Student #22: My major piques my interests, and I enjoy learning and doing the things in my major.

Student #23: Yes, biology and the body has always been the most interesting subject matter to me.

Student #24: Yes, pharmacy.

Student #25: I was encouraged by my father, and I know the job opportunity is high for civil engineers.

Student #26: Because I have always been interested in cpu's and circuits and how they all work together.

Student #27: I like metal. I like plastics. I like wood. I can do anything if I put my mind to it.

Student #28: Geological engineering because it's interesting to me. I like working outside and being hands on. Also this major has very good opportunities right now.

Student #29: Because I want to build stuff.

Student #30: I worked construction and I enjoyed creating buildings. Civil engineering degree will allow me to build on a larger scale.

Student #31: Yes, I love being outside and have always found the subject of an ever-changing earth.

Student #32: Mechanical engineering because I want to run my own factory one day.

Student #33: Because the world needs engineers.

Student #34: I chose my major because I love working on things and creating things.

Student #35: Yes, ME [Mechanical Engineering] as it is incredibly practical in today's society and the opportunities available allow for almost any career path.

Student #36: Yes. I originally planned on being a Chemistry major and going to med school, but once I realized that I might not want to go to med school, I switched to Chemical Engineering so that I would have more options after I graduated.

Student #37: It is broad—open to many opportunities after college.

Student #38: I chose to major in chemistry because I enjoy learning about the material.

Student #39: Geological engineering because I enjoy being outdoors and being able to physically look and touch things rather than current and things can't see.

Student #40: Yes, I like designing and building things.

Student #41: Yes, Mechanical Engineering. I chose it because of the wide variety of positions and knowledge that can be used/had with the major.

Student #42: Yes. It seemed to be a good fit, and I really enjoy the content.

Student #43: I chose forensic chemistry because it interests me. Physics is a part of my major but it is not the main aspect.

Student #44: Yes, previous exposure.

Student #45: It's easy.

Student #46: Yes, in order to pursue a career in an area I find interesting.

Student #47: Geological Engineering. To get into oil/gas or rivers and dams.

Student #48: Mechanical engineering, it is a very interesting field with many applications in the real world.

Student #49: Yes. Forensics has always interested me and Chemistry is my strong suit.

Student #50: I prefer putting physics into use rather than just studying and expanding on it.

Student #51: I chose Civil Engineering so that I would have a good foundation in the U.S. Navy.

Student #52: I like math so I majored in mechanical engineering.

Student #53: I love solving math problems. I like the construction business pretty much so I think civil engineering is a way to combine my interests in solving problems and massive structures.

Student #54: Yes. Geological Engineering allows me to work with my hands and be outside, while also challenging my brain with an intense math curriculum.

Student #55: ME [Mechanical Engineering] because it sparks an interest within me, and it's something I want to continue to learn.

Student #56: Yes. I chose my major because I knew I wanted a career that included both a scientific and mathematical aspect. Engineering was the best choice for math, and I enjoyed chemistry in high school, so chemE [Chemical Engineering] seemed like a good option.

Student #57: Yes, Chemical Engineering because I feel like it is a broad field and I would enjoy what I would do.

Student #58: Chemical engineering with a Pre-med pathway.

Student #59: Chemical engineering—I chose this major because the basic principles can be applied to the human body for drug design and delivery.

Student #60: Yes. I enjoy computers and working on them. I like to continue working with them in electrical eng.

Student #61: Chemical Engineering because it appealed more to me than the other engineerings.

Student #62: I love learning about the Earth and being outdoors. Adding engineering to it [the student's physics major] ensures job stability and I can use my math skills. [This student majored in physics and engineering.]

Student #63: Yes my major is biology because I would like to go to medical school.

Student #64: Physics is not my passion, but I do enjoy it. Since I knew I was pre-med, I chose a major I enjoyed and would provide me with information I don't receive in med school. [The student used the same answer for both Question #18 and Question #20. The student indicated this by using an arrow to point from their written answer for Question #18 to the space below Question #20.]

Student #65: Physics represents a method of thinking outside of the box and new problem solving; perfect for the future of medicine. [The student used the same answer for Question #19 and Question #20. The student indicated this by using an arrow to point from the space below Question #20 to the answer they had written for Question #19. The student was a Physics and Biochemistry major, and thus had already answered a very similar question in Question #19.]

Student #66: Yes, Pre-Pharmacy. I worked part time in a pharmacy and realized I wanted to be educated about medication and how they affect the body. I want to help people.

Student #67: Biology is easy for me and I enjoy the subject.

Student #68: Yes; I plan to go to medical school and I just needed a degree, so I majored in something I like and enjoy.

Student #69: Biology is my major because I want to pursue a career in medicine, and I felt that was a better fit for me. Also, I was never introduced to physics until college after I decided on Biology.

Student #70: Exercise Science because I enjoy it.

Student #71: My major really interests me and I have always wanted to do it.

Student #72: Yes (pre-pharmacy). I enjoyed chemistry in high school and want to be a pharmacist.

Student #73: Biology. It really interests me.

Student #74: It interests me.

Student #75: I chose my major because it would help me accomplish my goal of being a physical therapist.

Student #76: Yes, I really enjoy medicine and finding how different medicines affect the body.

Student #77: [No answer given.]

Student #78: Yes, Biology and Psychology. I thoroughly enjoy both subjects and have a deep interest in them. They also are more familiar to me as I have taken them before college.

Student #79: Biochemistry. I plan on becoming a physician, and the human body amazes me.

Student #80: Yes, because it combines my interest of the body with my love of sports.

Student #81: Biology. I feel as if Biology is the most applicable subject to everyday life.

Student #82: Yes. I like chemistry, and this major will give me a good background for medical school.

Student #83: [No answer given.]

Student #84: Yes. Family business.

Student #85: I chose biochemistry because I feel that it offers me a curriculum that is goaled in reaching medical school.

Student #86: I chose pharmacy as my major because I've always had a great interest in medicine and the entire medical field.

Student #87: Physics. [An extremely brief answer was given; this was probably due to the fact that the student, who was a physics major, had already basically answered this question in reply to Question #19.]

Student #88: [No answer given]

Student #89: I like chemistry and math. Chemical engineering.

Student #90: Yes, Pre-Med and Chemical Engineering.

Student #91: Yes, mechanical engineering because I enjoy making things and science interests me.

Student #92: I chose chemical engineering as I was investigating what engineering was (I had an interest in math, and wanted to apply it). I started really enjoying chemistry. So it made sense.

Student #93: I enjoy building/putting things together.

Student #94: Yes. My family is full of engineers, it's what I'm good at, and I enjoy it.

Student #95: Chemical Engineering. I am good at chemistry and calculus not physics.

Student #96: Yes, I chose chemical engineering, because I really enjoy chemistry and math, as well as the problem solving.

Student #97: I chose chemical engineering because I have an engineering problem solving mindset and the field is enjoyable.

Student #98: Mechanical engineering. A lot of job opportunities = $$$. Let's be honest here.

Student #99: Yes, biochem is geared towards pre-med students.

Student #100: Yes, I chose biology because I want to eventually become a doctor.

Student #101: Yes, I chose chemical engineering because I have always been excellent in math courses and have interest in learning chemistry considering life itself is surrounded by it.

Student #102: I chose ME [Mechanical Engineering] to comply with the qualifications of my scholarship; additionally, practical applications interest me in particular.

Student #103: Yes, Chemical engineering. I like Chemistry, math, and problem solving.

Student #104: Yes, I have chosen chemical engineering.

Student #105: Forensic Chemistry. Both science and Criminal Justice interest me, so a joining of the two seemed the best education option.

Student #106: Chemical Engineering. I really like math and chemistry.

Student #107: I chose ME [Mechanical Engineering] because I felt like it fit my skill set, and job placement out of college is very high for engineers.

Student #108: Yes, the major that I find most interesting.

Student #109: Yes. Because chemistry courses are required for dental school, and it is a solid major if I don't get in.

Student #110: Yes, because I want to go into R & D for high explosives and propellants.

Student #111: Mathematics because it is the purest science, every other science subject branches from it, and Biochem because the application of Math in that area is based off of rules that are concretely explained and observable. Biochem will also help for Medical School, physics is only a minor area needed.

Student #112: I chose chemistry because it is a rigorous course schedule that is impressive to medical schools (hopefully). I would have possibly chosen physics if I wouldn't have had to take extra summer courses to get my pre-med prerequisites, as well.

Student #113: Because I like chemistry I can have a future in it, being a forensic chemist. I also like to solve puzzles.

Thematic Analysis of the Written Responses of the Students (N_{Total} = 113) to the Short-Answer Questions on the Student Survey Form

Table 362

Answers to the Question of Whether or Not Students Enjoy the Subject of Physics; Compiled by Analyzing Common Themes in the Written Responses of the Physics Students (N_{Total} = 113) to the first part of Question #17 on the Student Survey Form, "Do you enjoy the subject of physics? Explain."

Thematic Category	Number of Physics Students	% of Sample (N_{Total} = 113)
Yes	55	48.7 %
No	27	23.9 %
Somewhat	28	24.8 %
No Answer was Given	3	2.7 %

Table 363

Some Aspects About Physics that Students Like or Enjoy; Compiled by Analyzing Common Themes in the Written Responses of the Physics Students (N_{Total} = 113) to Question #17 on the Student Survey Form, "Do you enjoy the subject of physics? Explain."

Broader Theme	Thematic Category (More Precise Theme)	Number of Physics Students who Mentioned the Particular Thematic Category in their Answer	% of Total List of Reasons Students Gave ($N_{Positive\ Listed}$ = 105)
Enjoy Math	I enjoy math.	9	8.6 %
Interesting, Fun	Physics is interesting	9	8.6 %
	Physics is fun.	1	1.0 %
	The labs are fun.	1	1.0 %
	I enjoy the lectures.	1	1.0 %
Logical and Thought-Provoking	I like the logical aspects of physics.	3	2.9 %
	Physics makes me think; it is thought-provoking.	3	2.9 %
	Physics makes sense.	2	1.9 %
Problem-Solving and Challenges	I enjoy solving problems; physics improves my problem-solving ability.	8	7.6 %
	I enjoy challenges.	1	1.0 %
Applicable to Life	Physics is applicable to life.	8	7.6 %
Applications	The applications are interesting.	1	1.0 %
	I enjoy seeing the solutions to problems have observable effects.	1	1.0 %
	Formulas and theories are useful for application problems in engineering.	1	1.0 %

Understanding and Concepts	I enjoy the concepts; I enjoy understanding the concepts.	8	7.6 %
	I like the parts where I can picture the problem in my head (non-theoretical).	1	1.0 %
	It helps me understand how things work.	8	7.6 %
	It helps me understand nature and the world around me; it helps me understand many everyday things I experience.	16	15.2 %
Objectivity	Few gray areas when it comes to testing.	1	1.0 %
	More finite than other courses; if you know it, you know it.	1	1.0 %
Aptitude	I have an aptitude (i.e. a good ability) for physics; physics is easy for me.	3	2.9 %
	I was introduced to physics at a young age by a family member.	1	1.0 %
Comprehension	I enjoy physics once I understand it.	3	2.9 %
	I enjoy physics when I have a good teacher.	3	2.9 %
Enjoy Particular Topics	I enjoy only certain topics.	5	4.8 %
	Astronomical physics is interesting.	1	1.0 %
	The concept of currents is interesting.	1	1.0 %
	I am fascinated by relativity.	1	1.0 %
	I enjoy mechanics.	1	1.0 %
	I liked learning about vectors.	1	1.0 %
	I liked learning about the circuit.	1	1.0 %

Note. The researcher made a tally mark by each concept or category mentioned in each student's written answers to the survey question. Thus, each student's answer could possibly generate several tally marks (or, contrarily, no tally marks) depending on how many positive aspects of physics the student referenced in his or her written comments.

Table 364

Some Reasons Students Do Not Enjoy Physics (or Some Negative Aspects of Physics); Compiled by Analyzing Common Themes in the Written Responses of the Physics Students (N_{Total} = 113) to Question #17 on the Student Survey Form, "Do you enjoy the subject of physics? Explain."

Broader Theme	Thematic Category (More Precise Theme)	Number of Physics Students who Mentioned the Particular Thematic Category in their Answer	% of Total List of Reasons Students Gave ($N_{Negative\ Listed}$ = 45)
Dislike the Math	I don't like math; the math is too complicated.	5	11.1 %
	Too much math to be used in the real world.	1	2.2 %
Physics does not Interest Me	Physics does not interest me.	3	6.7 %
	Some topics in physics do not interest me.	2	4.4 %
Does not Apply to My Future Life	It does not apply to my major; it does not apply to my future job.	3	6.7 %
The Pace of the Class is Too Fast	The pace of the class is too fast and not enjoyable; too much to do in such a limited amount of time.	2	4.4 %
	I would need many hours of study to enjoy it daily.	1	2.2 %

Physics is Difficult to Understand	Too “in-depth” [too much deep complicated theory and detail]; too much to comprehend.	2	4.4 %
	I do not particularly enjoy the parts I do not understand.	1	2.2 %
	I dislike physics because I have difficulty understanding the concepts.	1	2.2 %
	Physics is difficult for me to understand; I do not enjoy it because it is very difficult.	8	17.8 %
	I do not enjoy physics if the teacher does not realize that physics is difficult to understand; some professors assume students know a great deal about physics.	1	2.2 %
The Problems are Difficult	I do not enjoy physics when not enough examples are done.	1	2.2 %
	Every problem is different and it is hard to practice the problems to get better; the problems are more difficult than other subjects.	2	4.4 %
	I do not enjoy physics because there are a lot of abstract problems involved.	1	2.2 %
Poor Aptitude for Physics (i.e. Not Good at Physics)	I do not enjoy physics because I am not good at it.	1	2.2 %
	I do not think in a way that allows me to grasp the concept of physics.	1	2.2 %
Do not Enjoy Certain Topics, Concepts, or Aspects of Physics	Although I enjoy some concepts, there are also some concepts that I do not enjoy; I enjoy some topics, but there are also topics I do not enjoy.	3	6.7 %
	I do not enjoy all of the electrical work involved.	1	2.2 %
	I do not enjoy the material we have studied in 212 [i.e. calculus-based Physics II class]	1	2.2 %
	I do not enjoy the labs.	1	2.2 %

Other	The application of formulas is just explained as fact; there is not a proof for everything.	1	2.2 %
	The physics department here is shoddily run.	1	2.2 %
	Although I like the ideas and theories, I do not like the actual doing [of physics].	1	2.2 %

Note. These are the negative answers for Question #17. The researcher circled the negative answers, or negative reasons, and he tried to put them in categories and themes. The researcher made a tally mark by each concept or category mentioned in each student's written answers to the survey question. Thus, each student's answer could possibly generate several tally marks (or, contrarily, no tally marks) depending on how many negative aspects of physics the student referenced in his or her written comments.

Table 365

Some Reasons Why Students Choose Not to Major in Physics; Compiled by Analyzing Common Themes in the Written Responses of the Physics Students (N_{Total} = 113) to Question #18 on the Student Survey Form, "Why did you choose not to major in physics?"

Broad Theme	Number of Physics Students who Listed a Reason Categorized by the Broad Theme	% of Total List of Reasons Students Gave ($N_{Answers\ Listed}$= 124)
I am not interested in physics.	14	11.3 %
I am not interested in the types of jobs physicists do.	4	3.2 %
I am more interested in another subject, major, or profession.	44	35.5 %
Physics is difficult.	8	6.5 %
I dislike physics or don't enjoy it.	15	12.1 %
I don't enjoy physics theory.	2	1.6 %
I prefer application to theory.	3	2.4 %
The upper level physics classes seem complicated.	2	1.6 %
Do not want to be in the sciences.	2	1.6 %
I dislike the math that would be required.	3	2.4 %
Career/job prospects are better in another field.	7	5.7 %

Income is not high enough in physics.	2	1.6 %
I chose a major that would be better for preparing me for a career in medicine.	5	4.0 %
I chose a major that would be a good alternative degree in case I do not pursue a degree in medicine.	1	0.8 %
I wish to maintain good grades (a high Grade Point Average).	2	1.6 %
Family business needs engineers.	1	0.8 %
I did not really think about it, and I had already chosen another major.	1	0.8 %
I did not know much about physics.	3	2.4 %
I like working with people.	1	0.8 %
My scholarship only applies to engineering majors.	1	0.8 %
I did not realize how much I would love physics.	1	0.8 %
I plan to pursue a physics degree later.	1	0.8 %
I chose to minor in physics.	1	0.8 %

Note. The reason that there are more total answers (or reasons) than students was the fact that each student's written response could, in some cases, be broken into several different reasons—each of which represented a different reason and thus fit a different broad theme. Also, this table did not show the "more precise themes" that were shown in some of the previous tables; one reason the more precise themes were not shown is the fact that there were so many different ones. Showing all of the precise themes might have caused the table to become more cumbersome and confusing, and might have become redundant with the written responses of the students. There were a myriad of different reasons students chose not to major in physics. To see the precise wording of the various reasons, as they were listed by the students in their written responses to Question #18, one can observe the actual written responses of the students which were typed by the researcher and included in this dissertation. As mentioned earlier, it was possible for one student's written response to list more than one reason in such a way that more than one Broad Theme category was referenced. It was also possible for a student to generate no reasons (and thus, they would not show up in the above table of Broad Themes). For example, if a student left the question blank for some reason, or if the student left the question blank due to being a physics major, then the student would not have generated any reasons (or answers) that would show up in the above table. Another such example (of a student who generated no reasons or answers for the above table) would be the case of a student who gave an answer that was not applicable to this question. For example, a "joke answer" which has no application to the question would not show up in the Broad Themes for reasons why students choose not to major in physics.

Table 366

Some Reasons Why Students Chose to Major in Physics; Compiled by Analyzing Common Themes in the Written Responses of the Physics Students ($N_{Physics}$ = 4) who Answered Question #19 on the Student Survey Form, "Why did you choose to major in physics?"

Broad Theme	Number of Physics Students who Listed a Reason Categorized by the Broad Theme	% of Total List of Reasons Students Gave ($N_{Reasons}$ = 9)
I enjoy math.	1	11.1 %
I enjoy problem solving.	2	22.2 %
It will be beneficial for me in my pursuit of a career in medicine.	2	22.2 %
A degree in physics can lead to a wide variety of careers.	2	22.2 %
Physics will set me apart from engineering students when I apply to grad school.	1	11.1 %
Physics represents a method of thinking "outside of the box" (i.e. in an independent, different, and creative way).	1	11.1 %

Note. There were four students who answered this question, and there were nine answers (or reasons) given by them in their responses. If students had not chosen physics as their major, the instructions on Question #19 told them to skip the question. That is why only four students answered this question (Question #19), even though 113 students turned in completed (or mostly completed) survey forms.

Table 367

Answers to the Question of Whether or Not the Students Have Chosen a Major; Compiled by Analyzing the Written Responses of the Physics Students (N_{Total} = 113) to the First Part of Question #20 on the Student Survey Form, "Have you chosen a major?"

Answer Category (Concerning Whether or Not the Students have Chosen a Major)	Number of Physics Students	% of Sample (N_{Total} = 113)
Yes	106	93.8 %
No	0	0.0 %
No Answer, presumably due to having already answered it in Question #19 (since the student was a physics major)	1	0.9 %
No Answer, but a major was listed by the student in the demographic information	5	4.4 %
Answer Not Applicable to the Question, but a major was listed by the student in the demographic information	1	0.9 %

Note 1. One of the four physics majors did not answer Question #20, presumably due to having already answered it by answering Question #19. However, the other three physics majors answered Question #20—at least the first part of Question #20—in such a way that could be categorized as a "Yes" answer. However, one of these did so by using an arrow to point to his or her answer from Question #19. The researcher interpreted this to mean that the student intended to use his or her answer from Question #19 as the answer for Question #20, also.
Note 2. Another point to take note of concerns Student #77. Although Student #77 gave no answer for Question #20 (or Question #19), the student did list "pre-Rx" as his or her major in the demographic information section of the survey form. On the University of Mississippi website (see the link: "www.olemiss.edu/pharmacy/programs"), one can find that a B.S. degree is offered in Pharmaceutical Sciences; but the researcher (P. Rogers) saw no "Pre-Pharmacy" or "Pre-Rx" degree listed (at the time he consulted the website). If the University of Mississippi offers an actual degree titled "Pre-Pharmacy" or "Pre-Rx," the researcher is unaware of it. However, the researcher assumes that the student has chosen a major (such as "Pharmaceutical Sciences") which is probably meant to serve as a type of "pre-Pharmacy" major, but that maybe the student did not list the title of his or her major in the precise, formal way. Another possibility is that the student might be a transfer student from another college or from a community college which did have "pre-Rx" listed as an actual major. Ultimately, the researcher categorized Student #77 as follows: "No Answer, but a major was listed by the student in the demographic information."

Table 368

Some Reasons Why Students Chose Their Particular Major; Compiled by Analyzing the Written Responses of the Physics Students (N_{Total} = 113) to the Second Part of Question #20 on the Student Survey Form, "Why did you choose your particular major?"

Broad Theme (Concerning Reasons Why Students Chose their Particular Major)	Number of Physics Students who Listed a Reason Categorized by the Broad Theme	% of Total List of Reasons Students Gave ($N_{Reasons\ Listed}$ = 173)
I enjoy math or science.	15	8.7 %
I want to prepare for entry into medical school and a career as a doctor.	11	6.4 %
Interest in the medical field, the human body, medicines, and health professions.	19	11.0 %
I enjoy working with people.	4	2.3 %
Interest or enjoyment of the subject, major, or career.	41	23.7 %
I am good at it; it fit my skill set.	8	4.6 %
There are many job opportunities associated with this major.	12	6.9 %
Possibility for a high-salary job.	1	0.6 %
Practicality and applications, such as for building things, creating things, and working on things.	21	12.1 %
Desire to work outdoors.	5	2.9 %
I like problem solving.	6	3.5 %
It is challenging.	3	1.7 %
Previous exposure or prior work in a similar field.	5	2.9 %
I have always wanted to do it.	1	0.6 %
Family business; major or profession is common in the family.	2	1.2 %
Encouraged by a family member.	1	0.6 %
I wanted to comply with scholarship qualifications.	1	0.6 %
It offers a way to combine my various personal interests and certain career attributes associated with this major.	8	4.6 %
It is a solid major if I don't get into professional school.	1	0.6 %
So that I would have a good foundation in the Navy.	1	0.6 %

I want to run my own factory one day.	1	0.6 %
I will have a title when I graduate.	1	0.6 %
There is a wide variety of knowledge that can be gained or used with this major.	2	1.2 %
To get into oil/gas or rivers and dams.	1	0.6 %
I want to get into R&D [Research and Development] for high explosives and propellants.	1	0.6 %
It represents a method of thinking "outside of the box."	1	0.6 %

Note. There were a total of four physics majors, and not all of them responded completely to Question #20. The researcher assumes that this was likely due to the fact that they had already answered a very similar question (dealing with physics majors) in Question #19. Indeed, only one of the four physics majors actually wrote out a response to the second part of Question #20, which asked the students why they chose their particular major. However, another one of the physics majors did use an arrow to point from the answer space below Question #20 to the answer the student had written for Question #19. The researcher assumes that this was done to show that his or her answer to Question #19 was the same as his or her answer to Question #20. Thus, the researcher did re-type that student's answer for Question #19 as his or her answer for Question #20 (see written responses of Student #65 for Question #19 and Question #20). However, the reasons listed in Question #19 by the other two physics majors (i.e. the two who did not include any indication of a response for the second part of Question #20) were not included within the statistics shown in the above table for Question #20. The above table only includes the reasons listed by the students who wrote out a response (or indicated a response) for Question #20.

APPENDIX E: QUALITATIVE RESULTS: INTERVIEW TRANSCRIPTS (WITH THEME TABLES)

Transcripts of Interviews with 10 Physics Students at the University of Mississippi

The following pages contain the transcripts of interviews which the researcher conducted with ten physics students from the University of Mississippi. The researcher planned for the interviews to be approximately five minutes in length. However, some of the interviews were less than five minutes and some exceeded five minutes, depending on how the flow of the interview occurred. During the interview, the researcher endeavored to follow the basic questions shown on the student interview form [see *Qualitative Survey Form: (For Interview with Students)* in Appendix C]. However, if other interesting questions emerged, those were asked as well; and at times, during the interview process, the researcher failed to ask some of the interview questions. Overall, though, the researcher generally tried to follow the basic pattern of questions from the student interview form when conducting the interviews. The full transcripts of these interviews with the ten University of Mississippi physics students are included in the pages which follow.

Interview with Physics Student A (male) at the University of Mississippi (April 2013, Oxford, MS)

Paul: Do you think physics is an important subject?

Student A: I would definitely say it's important in terms of using physics; like, you know, most sciences we take in high school and stuff—you never actually get to apply it, and like, figure things out, you know, things that are actually useful. Like, Ole Miss runs a trebuchet competition where you actually get to use physics and apply it. You can, you know, change angles up, and get velocity, and all that. And so, I think physics [is] important in that you can actually apply it to real life stuff.

Paul: Yep. Well, that's good. Um…did you major in physics? Or, are you an engineering major? I believe you're probably an engineering major.

Student A: Pre-med.

Paul: Pre-med. OK. Well, if you had to say, like—did you actually major in physics?

Student A: No. No.

Paul: OK. OK, so we actually have a pre-med major?

Student A: Right. Well, it's a pre-med/exercise science, and I'm just using that degree for medical school. But yeah, you can do a lot of different majors.

Paul: To go to…to get into the pre-med program?

Student A: Exactly.

Paul: OK.

Student A: Right.

Paul: Well, I was wondering, like, if you just had to put it on paper or to understand better about why people choose physics majors, how would you answer this question: for what reasons did you not major in physics? If you had to say …

Student A: Honestly, I think it would have been an awesome major, as far as, like, information-wise and learning. Because, like I said, the MCAT [Medical College Admission Test], that I have to come up taking now in the summer, it actually focuses a large amount on physics. Like I said, you can apply it and stuff. But, in my high school—at least where I went, to a public high school [near the central part of MS]—I know that they didn't, uh…the physics education department was very…just not orderly; didn't focus much; our teachers hardly ever even really went over stuff. A lot of times, we just sat there. It was kind of—I think the end of my junior year I took physics in high school…for a year. But, uh, they didn't emphasize it enough for you to even want to, like, really major in it.

Paul: Yeah. OK. Well, do you feel that you are well-prepared for your physics class?

Student A: From the way that Ole Miss teaches it, I came in—I don't feel like I was prepared. No. Not for physics. But, I mean, I did fine in it. I made an "A-minus" in the first one. It's very—I mean, it's hard at Ole Miss.

Paul: Yep.

Student A: But it was only because I had to work so much harder to catch up, I felt like; because the high school, in my opinion, doesn't prepare you enough for the college-level physics—what physics really is.

Paul: Yep.

Student A: But, yeah, it—I don't think I was prepared, like I should have been, coming in.

Paul: OK. Well, I was just—this is sort of a side question. But, from your classmates … like, compared to them…do you think, if you had to guess, like—and you went to school in Mississippi, it appears, from what you had said—do you think most of your classmates at Ole Miss are sort of in the same situation, if you had to guess?

Student A: If they were in a Mississippi school, definitely.

Paul: That's…your general feeling?

Student A: Yeah. Because, I feel like, from what I know—um, like, from my knowledge, compared to the class, it's pretty high. But, at the same time, still the class is way up here—the bar is up here. And, I feel like the school that I went to, they weren't even trying to prepare you for what was coming up if you had to take it at college level.

Paul: Yep. Do you think it may be—this is another side question—but do you think it…like…what reason, what would you theorize might be the reason for that? Like, if you had to say. Like, is it maybe…maybe that sometimes there's…maybe when people are in high school, they—maybe the teacher really was not a physics major or something? Or…

Student A: Oh, definitely…

Paul: …like, what would be your [opinion]?

Student A: ...because, I know in our high school—it was a crazy story—but our physics teacher, it's just kind of like the teacher was just thrown in the position. So, it's like, I remember our first physics test; I think it was like, we didn't do problems, like you should be, trying to figure out real-life situations—like in college, they ask you word problems, and you have to think through it and figure it out. Whereas, I think in high school, I had like—my first test was multiple choice. Which for physics, you can't give a multiple-choice test and think that that's going to give you the knowledge for math, and all that, that you should know.

Paul: Right. Yeah. Well, what would—this is probably the last question—but, what could be done to help students have a better experience with studying physics, in your opinion?

Student A: At the college level? Or, at the high school level?

Paul: Well, that's a good question. Like, you could…I guess…either way. Like, "in general," then. I guess. That's—well, maybe we'll start with high school. Like, in high school, what could be done—and then, then maybe in college—to help students have a better experience studying physics?

Student A: Honestly, I think [that in high school] they need to teach it earlier. And, they need to have more courses and curriculum in physics; because, at my high school, you didn't even have to take it if you didn't want to; you didn't have to take it at all. But, it was, like, voluntarily; you could take it; and it was only one course. If you wanted to, you could only take basic Physics One.

Paul: Yeah.

Student A: And it's like, if you wanted to take more to prepare yourself even more, they didn't even offer it.

Paul: OK.

Student A: And, this was at a, I mean, like a Five-Star school, too—like highest test grades in Mississippi and all that—and they still only have one physics course.

Paul: Yep.

Student A: So…look how the other high schools could be. They probably don't even have a physics [course]—a lot of them.

Paul: That's a good point. That's a very good point. Well, and at the college level, like, do you see anything—like, at the college level, what would you say if…do you see any room for improvements? Or do you pretty much like it the way it is, if you had to say what could be done to help students have a better experience with studying physics?

Student A: Umm, I like it…college level, I mean, they teach it pretty well, except for, I don't think they focus on enough concepts.

Paul: Um hmm.

Student A: I think it's so much math, and it's so much focus on the word problems, that they don't explain what this means.

Paul: Yeah.

Student A: Umm, which on the MCAT, that is—it's all concepts. You're not doing a word problem on the MCAT; they're asking you what does this mean when this happens or something like that.

Paul: Yep.

Student A: So, but other than that, I think college-level teaches it pretty well—from, at least from being at Ole Miss.

Paul: OK. Well, is there anything else that you would like to say about physics—like, that you would like to put on the record?

Student A: Not that I can think of.

Paul: OK. Well, I thank you for doing the interview with me today, and I guess that concludes our interview.

Interview with Physics Student B (male) at the University of Mississippi (Summer, July 2012, Oxford, MS)

Paul: Do you think physics is an important subject?

Student B: I do think it's important. I mean, basically it gives us a look at, you know, why everything around us works. I mean, it gives us answers to why we don't float up in the air; and how light works when you turn on a light switch; and just…I mean, pretty much answers everything about nature and the universe and everything else. It just gives you the key to understand what's going on.

Paul: Uh huh. OK. Well, did you major in physics?

Student B: I really didn't. I major in biochemistry.

Paul: Uh huh.

Student B: I've wanted to be a doctor since I could…since I can remember. And, when looking at majors, I just felt like that was the one that was the best designed to take me to med school; because looking at requirements of the couple of schools I wanted, it pretty much followed right along with all of their requirements.

Paul: OK. So, I know biochemistry and biology-related things are very common for, like, pre-med majors. But…some of my research deals with why students choose to major in physics or not to. And so what, if there is a reason you could say you really didn't choose physics, like what would it—was it because you didn't know about it—or what would it be? Or just better other options? Like, I don't want to put the words in your mouth, but how would you—if you had to answer that question, like, why you didn't choose physics—how would that be?

Student B: I mean, I find physics to be fairly easy as a course. I've never really had any trouble with taking the class. In high school and college, I've been very successful. But, umm, I just—I've always been more interested in chemistry. That's really my main focus in the biochemistry. I'm minoring in chemistry…just because I've always been really interested by, like, lab experiments, especially in chemistry.

Paul: Yep.

Student B: And also, if I were to major in something else, it would require a lot of extra work; because, there's a lot of classes that wouldn't be on my curriculum that I would still have to take, like, as electives in order to get in…to med school.

Paul: OK. Well, do you feel that you were well-prepared for your physics class?

Student B: I do feel like I was pretty well-prepared. Umm, I am taking the algebra-based [physics course], but I've actually had all the way through Cal Four [Calculus IV]. So it's kind of—there were a lot of stuff that I kind of had to go back to that I was like, "OK, I've got to remember how to do basic algebra. Because, it's been so long since I've done regular algebra." But, I did take physics in high school. And, I felt like physics—the first semester class—was pretty much right along with what I remember learning in high school, with just a little bit more in-depth on the topics. So, I felt like I got a good base in high school, and it helped me to really be successful when I came here and was taking it over again.

Paul: OK. Well, what could be done to help students have a better experience with studying physics or physics classes? Like, what could help students have a better experience?

Student B: Well, I mean, I think that physics is just like any other math class, really. Like, it really just takes the time to sit down and really work with the material; because if you don't work with it, you're not ever going to really learn it. And, I mean, you can work it once or twice and have the right answer, and know that one type of way to do it; but that doesn't necessarily give you the entire understanding of how it is. And it just takes a lot of, you know, sitting down working a lot of different types of problems, and really just, umm…just making yourself do the work; because that's really what will help you be the most successful; because it gives you a way to look at it to where you understand why the problem is worked this way and how the math is done, instead of just how to plug numbers into a formula.

Paul: Yep.

Student B: Because that really helps you—because then it doesn't matter what kind of problem they give you, you're going to know how to work it…if you get that full understanding.

Paul: Yeah. OK. Well, I thank you for conducting the interview with me, and unless if you have any further questions or comments, I guess that's the end of our interview.

Student B: Alright. Well, you're welcome. Thank you.

Paul: OK. Thank you.

Interview with Physics Student C (male) at the University of Mississippi (April 2013, Oxford, MS)

Paul: Do you think physics is an important subject?

Student C: Yes.

Paul: OK. For what reason would you say that?

Student C: I think it's really important because it kind of shows how everything actually works; like, from the little things (like electron level), to like cars, and the whole world; and pretty much, like, the universe and everything, how it all works and came together; and…

Paul: Yeah.

Student C: …it's good at explaining everything at a deeper level…than most other courses can.

Paul: That's a good…that's a good way to put it! [laughing softly]

Student C: [laughing]

Paul: Well, did you major in physics?

Student C: No. I major in biochemistry.

Paul: OK. For what reason did you choose biochemistry over physics, if you could say?

Student C: Well, I'm more interested in, like, the biology aspect anyways, but I didn't want to take just biology…and chemistry. Because, I'm better at those subjects than physics; and because I'm on the pre-med track, and I thought those would gear me more towards doing better on the MCAT and everything.

Paul: OK. Well, did you ever—like, during that time—did you ever, possibly…did it ever run through your mind, maybe, to at least consider physics sometimes? Or did it…[inaudible word/s].

Student C: I thought about it; especially—I mean, I took it in high school. So, it was really interesting then, too. And I came here, and I'm still really interested in it. But, I'm not good enough in it to actually major [in it].

Paul: OK.

Student C: But, it did interest me—the theory behind everything.

Paul: OK. Well, do you feel that you are well-prepared for your physics class?

Student C: I do. Well, Two-eleven [211, calculus-based Physics I] was more of, like, the gravity and all that stuff. Two-twelve [212, calculus-based Physics II] is the more electron and the magnetism part. So, I felt better for Two-eleven, because to me, it was easier to grasp the concepts.

Paul: Yep.

Student C: For Two-twelve, I still feel prepared; but it's harder…because it's smaller.

Paul: Yep. [Because of] electricity and magnetism and things?

Student C: To me, it's just harder because it's hard to grasp…

Paul: Yep.

Student C: …because it's so small.

Paul: Yep. That's understandable. And, it's like…I've found that it's…that it builds so much on top of other things.

Student C: Um hmm.

Paul: And, it is very difficult—at times. But, it's interesting.

Student C: Yeah…definitely Two-Twelve is more interesting than Two-Eleven; because it's more of how things happen…and why.

Paul: OK. And, like…and you went to a—am I correct that you went to a Mississippi school?

Student C: I did. I went to [a public high school near the central part of Mississippi].

Paul: OK. Well, that's good that you felt well-prepared. And, that's one of the things we're studying is how students feel as they come into college and from their high school course. Well, what could be done to help students have a better experience studying physics?

Student C: Umm…well, there's no way to make it easier, but, umm, I guess just…to me, it'd make more sense if there was a theory-based class that went along with the math part.

Paul: Uh huh.

Student C: Like, there's a physical science class here that I think is a lot of the theory behind it. But, I think they should also have to learn the math part, but maybe like a recitation or something that would help them understand both concepts. Because, putting them together is difficult—because, I'm better at understanding the theory than I am with the math part.

Paul: That's a very good point you make, that someone else has made: that the concepts…that the math sometimes confuses the concepts, in a sense. And, I didn't think about it like that, but that's a good point. Well, do you have anything else that you would like to say about physics or anything?

Student C: I can't think of anything.

Paul: OK. Well, I thank you for the time, and that really concludes our interview.

Interview with Physics Student D (male) at the University of Mississippi (April 2013, Oxford, MS)

Paul: Do you think physics is an important subject?

Student D: I definitely think physics is an important subject. Physics surrounds our everyday life, and is very relevant to everything that we do. But, I mean, I am not one that really likes to partake in physics much. I am a mechanical engineering major. But, of course, physics is very important, and it solves many questions in our daily lives.

Paul: Well, I was going to ask, "Did you major in physics?" but, as you said, you were an engineering major. But, what are the things—like whenever you were considering careers—if you had to say, what are the reasons that you chose not to major in physics? What was it that maybe—how would you answer that question? Like, what are the reasons you did not major in physics?

Student D: Sure, umm, well…I mean, yeah, of course I like math, because I'm an engineering major. Umm, I don't know, I just…I am more interested in the engineering aspects instead of the more physics aspects of stuff. Umm, I am in mechanical engineering, so I am interested in, like, factories and different kind of machinery and all that kind of stuff, instead of more like theories…

Paul: Yep.

Student D: …I guess.

Paul: OK. Well, do you feel that you are well-prepared for your physics class? How would you answer that question? [chuckling]

Student D: Umm, my physics class is a difficult class. I try to study in and out of class. Very occasionally, I try to, you know, do my homework, you know, do my studying, you know, my good bit. I feel that I am not, I guess you could say, as smart or as prepared (or whatever kind of word you would want to use) as other students in the class. However, I mean, I feel like I am doing decent, and I just don't see myself going towards that career path…

Paul: Yep.

Student D: …in future years.

Paul: OK. Well, this is sort of a different question, but would you say—I don't know, but—would you view it as wasted effort if you worked much harder? Or, do you view it as being that even if you worked hard, it would probably, you know, be not something that you might be able to grasp? How would you answer that?

Student D: Grasp…in physics?

Paul: Yeah. What…I guess, to rephrase it, what I'm trying to see is, like, students that really maybe view themselves as not at the, you know, the "A-level"—is it because, in your opinion, that maybe their interest is not in that subject, so they don't waste time in it? Or, how would you answer it?

Student D: So you're saying, like, are some people more interested in physics, so therefore they would like it better?

Paul: Yeah. Like, how would you say it? How would you answer it?

Student D: Umm, I definitely would agree with that. Like, if you're more interested in some kind of field, you're obviously going to do better in it; because you're more interested, and you like to study it more.

Paul: Yep.

Student D: Instead of someone that's a non-physics major, they're just like, "Aww, I have to go to physics class. I have to study for physics;" and like, dreading on it. And so, I definitely think that takes a big factor within it. Umm, I mean just, if you don't like a class, you don't necessarily want to go to it.

Paul: Yep.

Student D: And, then you don't necessarily want to study it.

Paul: Right. But obviously, you're quite intelligent—I know that just from being an engineer [not actually an engineer, but an engineering major at one time]. That's a very—I guess it requires much intellect, as you know. [chuckling] So, I didn't mean to say that you couldn't grasp it. I was trying to understand sort of how engineers view physics—or some engineers—versus how, you know, you were saying, like, a theoretical physicist that's interested in the deep theory…which, being in physics, I know that that takes many years; and it will seem sometimes as if you can't grasp it.

Student D: Yeah.

Paul: Although the intelligence, in my opinion, is there.

Student D: Yeah.

Paul: But often, students sometimes will feel that they just can't grasp it. And I didn't know if maybe…maybe that you had sometimes felt that…

Student D: Definitely.

Paul: …or, if it was the interest in engineering that sort of led you to spend your time there, and just sort of maybe not have as much time to spend with physics. I don't know.

Student D: I guess you could say kind of both, a little bit. I definitely have more of an interest toward engineering, and not as much of an interest in physics. So, I'd rather spend more time in that than in physics. And, I guess I would just…I don't know, maybe…more prepared for engineering classes and whatnot.

Paul: Yep. Which is what you're interested in! [laughing]

Student D: Exactly.

Paul: And that's…that's definitely understandable. And, that's…that's sort of where I was going, you know, what I was trying to—it's hard to word that question—but that's what I was trying to "shoot at"…

Student D: Sure.

Paul: …is to understand the difference in how sometimes engineering students versus, you know, a theoretical physics student, would think about it. Well, the other question is: in your opinion, what could be done to help students have a better experience with studying physics?

Student D: Umm…I would, I guess, say…I don't know, I guess try to have outside tutoring sessions or something.

Paul: OK. I could have said, "What could be done, if anything?"…you know, "In your opinion, could something be done? Or, if you think something could be done, what could be done? " That's probably how I should have phrased it.

Student D: I don't really know. I mean, like…I mean, if they don't necessarily like studying, it's kind of difficult to push someone to do that.

Paul: Right.

Student D: I mean, I could only just say, like, just keep pushing somebody; and just keep them going, I guess; and just try to get it in, like, their head or something. I don't know.

Paul: Yeah. Well, am I correct in basically saying that it seems to me that pretty much what you're saying, if I'm correct, is that there's really no problem with the way, in your opinion—and you can tell me if I'm right or not—but there's really no problem, really, with the way it's being taught; it's just, like, some people are more interested in other things, pretty much; is that correct?

Student D: I mean, like…yeah. I mean, like, of course it's a little bit of how it's been taught; I mean, because there's different teachers and whatnot. But, I mean, I think mainly it's the interest, and if you like it or not. And, I mean, if you don't like it, then [it's] kind of hard to pay attention in class, I guess.

Paul: Yep. Well, is there anything else that you would like to say…about physics or anything?

Student D: Umm, I mean, I think physics is very interesting. And, I have several friends that are physics majors, and they talk all about their…all their physics stuff. And

I’m just…I mean, like, it’s very interesting, and it’s very cool to hear. And, I love hearing about, like, theoretical physics stuff; not necessarily learning about it. I mean, one of my good friends is a physics major, or a double—uh, it’s a physics major and a mechanical engineering major.

Paul: Uh huh.

Student D: And, I just don’t know how he could ever do that. And, it’s ridiculous…how much work that is. But, uh, I mean, physics is very important, and it’s very—you know, it applies to our everyday life.

Paul: OK. Well, I thank you for the interview, and I think that…I think that will be enough.

Interview with Physics Student E (female) at the University of Mississippi (Summer, July 2012, Oxford, MS)

Paul: Do you think physics is an important subject?

Student E: Yes, I think it’s important just because you learn, like, how things work, how currents flow. You learn how things work.

Paul: Right.

Student E: And, I think that's important to know.

Paul: OK. Did you major in physics?

Student E: No. I'm majoring in chemical engineering, but I'm going pre-med. So, chemical engineering is more of a back-up.

Paul: OK. Well, did you ever even really consider physics as a major? In other words, basically, why did you choose not to major in physics? [chuckling]

Student E: I think I like more of, like, research and hands-on, and I feel like with chemical engineering, you're more of a hands-on, or you can do more of the research, more so than, like, just a physics major.

Paul: OK. Do you feel that you are well-prepared for your physics class?

Student E: Umm…well…took it in high school, but it was a lot. Like, I took the trig-based in high school, so coming in and doing cal-based physics was a whole new thing. Where I knew what a current was, or I knew the definitions of something; the actual way of deriving the formulas and using them, and putting them in the concept, was a lot more difficult than my high school course. So, it was a "so-so" prepared.

Paul: OK. And it is—I realize in the summer, it's often very fast-paced, also.

Student E: Oh, the summer ones fly through, and it's hard to really…I mean, it's studying every night, late at night. I mean, you're constantly doing physics.

Paul: Right. What could be done to help students have a better experience studying physics?

Student E: Umm, one of the things that we've done this summer is: we've always had groups. And, every time we do something, we have a group together; and we're studying physics or going over this. And it's a lot better than trying to sit down and study it by yourself, because you can talk out a homework problem with someone else and come up with the solution. And, it's easier to talk to someone than sit down and just try to look at your book and figure out the answer; because when you have someone else working, it really makes it easier of…getting it right, and just seeing…like, they might understand it, and you don't, and they can explain it to you. So, it's always better to study…I've always…studying with people is always better for me.

Paul: OK. Well, I thank you for the interview, and if you have no more comments, I guess that's the end of the interview. Thank you.

Student E: No problem.

Paul: [I] appreciate it.

Student E: No problem.

Interview with Physics Student F (male) at the University of Mississippi (Summer, July 2012, Oxford, MS)

Paul: Do you think physics is an important subject?

Student F: I think it is one of the most important subjects; because, physics may not provide such a immediate advance in technology, but over time, engineering and, like, engineers, use the knowledge gained through physics to apply to today's technology and to today's society. So, it's a great subject to study just to have a background in it, because it's always good to understand how things work around you—stuff like that, just common sense. But, those of us who want to go deeper into physics and do research and stuff like that, I think it's important…just for future generations.

Paul: OK. Did you major in physics?

Student F: I'm not currently majoring in physics; I'm majoring in civil engineering, because I want to pursue a career in the United States Navy as an engineer. And then, after three years of that, I want to go back to graduate school and finish a Master's of Science in physics; and then, possibly a PhD later on down the road.

Paul: OK. Well, what was it—well, actually you answered the question why or why not—but what is it that draws you towards physics to make you sort of interested in the subject?

Student F: Well, when I was eight years old, my dad introduced me to physics—not the typical physics, but more so astrophysics…

Paul: Um hmm.

Student F: …study of the stars, stuff like that. And then ever since then, I've always been interested in how stars work, how galaxies form, how things work in the universe. And that's what really introduced me to the subject. And that's what I want to get my Master's in, is astrophysics.

Paul: OK. Well, whenever you came into the physics class, did you feel well-prepared for the physics class?

Student F: Yes; um, I had physics when I was in high school, my senior year. So, when I had Physics One last semester, I felt like I knew most of it already. And so it was more of, uh, kind of a brief overview of what I already learned in high school. And so, I felt pretty prepared. Physics Two that I am taking now, not so much; because we didn't cover it in high school. But I feel like the background that I got last semester in Physics One really prepared me for…for Physics Two. So, yes.

Paul: OK. Well, I was wondering, like…the type of high school…it's sort of…to make…I'm studying, like, the topic of Mississippi physics, as well as just "in general"; but was your high school, was it out-of-state or was it in the state of Mississippi?

Student F: It was in the state of Mississippi.

Paul: In the state? OK. OK. Well—because I've heard from other students that there are…we have a few high schools here, and maybe more than a few (I don't want to jump to conclusions), that really give students a good background. And, so I was just curious about that.

Student F: Well, it turned out, um, that our physics course was just created two years before I took it. And so, it's a very new course for our high school. And there were still some bugs with it, but I think it turned out to be a great addition to our school.

Paul: OK. Well, like in your opinion, what could be done to help students have a better experience in physics—or a better experience studying physics?

Student F: From what I've seen in the past year—studying physics here—is that a lot of kids just have a bad experience in the classroom that makes them not want to go home and study. It just makes them not want to continue with physics, because they had a bad experience with a teacher or with the subject.

Paul: Um hmm.

Student F: And so I think, you know, if teachers can keep their students interested in the course, keep them from sort of wandering off mentally in the course, kind of keep them involved in class, don't let them drift off; then that may help. Because, I feel like a lot of kids just have a bad experience with their teacher or just with the course, and that keeps them from wanting to move on with the subject.

Paul: OK. Well, I thank you for conducting the interview with me, and unless if you have any further comments, I guess that's the end of the interview.

Student F: Alright.

Paul: Thank you.

Interview with Physics Student G (male) at the University of Mississippi (April 2013, Oxford, MS)

Paul: Do you think physics is an important subject?

Student G: I would say that physics is—since it embodies so many subjects in science, it's the basic science. So, if you want to do anything in the field of science (which can encompass everything from auto body repair to, I guess, string theory research), if you don't have a grounding in physics then your education is just lacking. So, from early on, you probably need a grounding in physics, either from your teacher or from some other source. Now, I don't know if things like EMF, or optics, or high-level more difficult things are applicable in everyday life. But for myself—I'm a mechanical engineering major—most topics in physics, if not all, are going to be useful.

Paul: Yes.

Student G: So, I guess it depends on the context; but I would say that physics is a very important subject, if not one of *the* most important, especially in secondary education.

Paul: OK. That's… that's what I felt when I was coming up, also. But, that's a good answer. Well, I was going to ask if you were a physics major, but you had mentioned that you were an engineering major.

Student G: Right.

Paul: But, did you ever possibly consider physics as a major? What were the factors that may have sort of leaned you away from physics?

Student G: I did consider it. My mother is a physics teacher in high school. Not only was she *a* physics teacher, she was *my* physics teacher.

Paul: Uh huh.

Student G: So, I've always felt the influence of science education pretty strongly. But, as it turns out, I'm also—I also joined the military. I'm in Navy ROTC right now. And, the scholarships they have stipulate: to get the full benefits, you need to have some sort of technical major like mechanical engineering.

Paul: Uh huh.

Student G: Physics falls into, like, the "B" category, where you might get it taken away if money runs out.

Paul: OK.

Student G: So, for security reasons, mostly, I chose mechanical engineering, but I was always leaning towards it because of its practical applications—[which] always attracted me. It goes over much the same subjects; in most campuses, I believe, they have you trained in classical physics; not necessarily just the statics with the beams and all the applications, but they actually have you go through and see the derivations in class—in physics class.

Paul: Yeah.

Student G: And, that's because you need to have appreciation for it, if you ever want to further even the mechanical engineering field. So, I knew all that was going to happen, even if I did mechanical engineering or even something like chemical engineering; they all take physics.

Paul: Uh huh.

Student G: So, even though I was interested in the subject, I knew that I could also *not* do physics, and still do it at the same time.

Paul: Yeah.

Student G: Win-win situation.

Paul: OK.

Student G: I'll never do research in the subject, but at least I'll have been able to do it anyway. Because it interested me, too.

Paul: OK.

Student G: My mother wanted me to do it, too.

Paul: OK.

Student G: So….

Paul: Well, this is sort of a side question, but—you can tell me if I am right or wrong…it's sort of a leading question, but I'm trying to understand it better. But, would you say it may be a case where practical considerations, as far as jobs and things, might—you know, basically financial considerations—may have caused you to maybe choose engineering over physics, even though you really like physics? Would that be a correct way to say it?

Student G: That sounds about right. Uh, I would say this is a practical, monetary incentive—although I'm not interested in money, but I do need money to get through school.

Paul: Yep.

Student G: Umm, if it weren't for my scholarship, I couldn't attend school. So, it was a significant drive in my decision to do mechanical engineering instead of physics, definitely.

Paul: OK.

Student G: Umm, physics…physics was always a little too abstract for me. I really like applying things to…applying it with my hands.

Paul: Uh huh.

Student G: I would rather buy a cheaper car that I know how to work on—that kind of thing.

Paul: Yeah.

Student G: So, even though physics interested me—like, when I first learned about, like, relativity and time dilation, my mind was blown. I was the only person who wasn't asleep…

Paul: Yeah.

Student G: …because, you know, the lights were down because they've got to have the projector on; everyone was asleep…and I was up here on the edge of my seat.

Paul: [laughing softly]

Student G: But, I just never could think of—I enjoyed mechanical engineering the same way. I enjoy machines the same way as I do physics, and it's secure.

Paul: OK.

Student G: So, that's—not that you can't have a secure job in physics, [you have] lots of contracting opportunities—but, as far as research goes, if I got into research, the money is just not as readily available. Or, at least that's been my experience. I might be very wrong, but when I looked into it, about two or three years ago when I was looking into majors, the money was just not as prolific as in other fields.

Paul: OK.

Student G: Um, and that was a concern for me. I needed to go to school.
So…[chuckling]

Paul: Yep. But, the actual subject, itself—like, if it…let's just say…let's just look at it from a subject standpoint. Like, if you had to say which—if you could just have infinite amount of money, and you wanted to choose a subject to study, you know, all of your life, would you—like out of mechanical engineering and physics, out of those two, which would you probably choose in that situation?

Student G: I very well might have gone with physics. Umm, just because if I had all the resources in the world, it is…it encompasses everything, including engineering principles. You need to build machines in order to conduct research. So, there are all of those things that I was interested in. So, yeah, I very well might have chosen physics over mechanical engineering, just because of the…symmetry to it, I want to say—kind of a aesthetic aspect to the math behind it.

Paul: Yep.

Student G: The mechanical engineering math is very ugly. It's very, "Well, this is just an approximation." You see lots of squiggly equal signs and things like that.

Paul: Yep.

Student G: Because, it doesn't matter. And in physics, they don't usually do that. If you do see an approximation, it's because you're about to take a limit; and you get an exact answer anyway. That's what I liked about it, I guess.

Paul: OK. Well, do you feel that you were well-prepared for your physics class?

Student G: I think I was. But, I think I am the exception and not the rule.

Paul: Um hmm.

Student G: Like I said, my mother taught the physics class, and I had a very early exposure to science classes because of my parents. They both valued science education very highly. Reading and math—I started to reading at a young age, and I did…I started doing math.

Paul: Uh huh.

Student G: But, accelerated programs were the reason that I moved to the specific spot in [a state in east/central USA] that I moved to.

Paul: Um hmm.

Student G: My parents were the ones that definitely got me into it earlier. So, I was prepared better than I think most of my peers are. I was the…I'm the one that everyone's [asking], "Hey, do you know how to do this optics problem?"

Paul: Yep. [laughing softly]

Student G: "Is the radius of curvature here positive or negative?" I was the person, because I had seen it all before in AP Physics—most of it. I shouldn't say "all of it", because the things like, uh, E-waves and things, and E and B fields, I hadn't seen before—some of the EMF stuff.

Paul: Yep.

Student G: But, kinematics—I was doing that when I was fifteen years old. So….

Paul: That came easy to you, pretty much?

Student G: It was pretty natural. Umm, I remember the first time we—my mother was brilliant in this, because we launched rockets. And then, we had these kinematics equations. And you knew the force of the rocket. And, we had these equations, and if you did them right, you could find your rocket again because you knew where it landed.

Paul: Hmm.

Student G: That was a fun experiment…

Paul: Yeah.

Student G: …and it shows you—and that's what really got me into the idea of using it to apply it to things like that.

Paul: Like, in engineering?

Student G: Every little symbols on your paper actually correspond to what really happened.

Paul: Yep.

Student G: And that was the—so I got into it very early. I think, comparatively, I was much more prepared than most people are.

Paul: OK.

Student G: And, I'm thankful for that, because this…this was not—uh, Physics Two was not an easy course…

Paul: [chuckling] No.

Student G: …to go through. [chuckling]

Paul: And, that—this wasn't a Mississippi school or anything, was it?

Student G: No. This was actually a [state in east/central portion of USA] school.

Paul: OK.

Student G: [Student G also gave the county and state in which the school was located.] It's…it's not the highest rated or the lowest rated school, but it did have one of the only AP Physics teachers…in a very long while…

Paul: That's good.

Student G: …maybe a hundred or two-hundred miles. So, people would move there for the science—science wing up there had won awards and stuff like that. Umm, so…Mississippi schools, they have a reputation—I don't know if it's earned or not.

Paul: Uh huh.

Student G: I don't know enough about the education system. My mom could go on for hours about it…

Paul: Yep.

Student G: …as she's written papers and things on science education. Umm, but I don't know enough about the subject to really expound on it—the difference.

Paul: Yep. Well, we're…we're…like, this study is actually… it starts with Mississippi, but we actually are—like, I'm interested personally in, you know, schools in the entire United States.

Student G: Right.

Paul: Because it…it's just—you know, it branches out. And, a lot of things that apply in Mississippi apply in [the state where Student G went to school], or other states, and even in the whole world.

Student G: Right.

Paul: Like, I'm interested in physics…

Student G: All people learn the same way everywhere, I suppose.

Paul: Yeah. And, that's—so I was just curious, because it's sort of for the research to sort of understand differences and similarities.

Student G: Um hmm.

Paul: And, hopefully, it will help, you know, help all of us to be better…

Student G: Right.

Paul: …better at physics, and better prepared, and make classes easier…and make you learn more, hopefully, as you're in the class. But, the last question…that I would like to ask: what could be done to help students have a better experience with studying physics, in your opinion?

Student G: That's…that's definitely a hard question. Umm, what I absolutely despise in my entire education is night labs. Anything after about six o'clock in the afternoon…six o'clock in the afternoon you've got a two-hour class to look forward to, where you're watching a weighted turn-table go around for thirty seconds at a time for about an hour. That's…that is the most depressing thing that I've ever done in my whole life. It was an angular momentum experiment.

Paul: Yep.

Student G: Some of the experiments are very interesting. But, sometimes, they could be sped up, or conceptualized better, or faster, or something.

Paul: Uh huh.

Student G: Uh, some of the subjects…some of the concepts, uh, don't necessarily need to have labs attached to them, I don't think.

Paul: Yeah.

Student G: Umm…I know that not all of them do, but that would go a long way towards increasing interest in your classes, is if the labs were more…well, were more interesting, umm, the demonstration of the concepts are better. Now, a lot of times, what will ruin a lab more than anything else is faulty equipment.

Paul: Yeah.

Student G: And, you have to make up your values. And the TA doesn't know what to do. You don't know what to do. You don't know what it's supposed to be. So, if equipment was tightened up and always working fine—which, I know, is a perfect world, but—that would make the labs faster, more enjoyable, and they would hammer the idea home much better.

Paul: Yeah.

Student G: Umm…when I'm shooting a ball with the little spring-loaded cannon, I know where it's supposed to go. I know about what my answer is supposed to be.

Paul: Yeah.

Student G: But sometimes, counting…counting, uh, the little bands of light on an interferometer à la double-slit experiment…

Paul: Uh huh.

Student G: …when your laser is too close or the…it's not set up correctly, and you can't quite see them, you have to lean in, that is what drives me nuts about the labs.

Paul: Yep.

Student G: As far as teaching goes…I have a particular professor that's very interested in the mathematics; and he derives the equations for us, which is nice for some people.

Paul: Uh huh.

Student G: But, I think for some people, he loses them; and they just kind of give up. And when you actually see: you don't always need to take a double integral over a closed surface to find the flux over something—uh, the change…the change in a magnetic field in something. Sometimes, you just need to remember how to do it. This is a…a sphere has a certain one, and a ring, and all these have certain equations for them.

Paul: Yep.

Student G: And, that's the practical side of it for passing your tests.

Paul: Yep.

Student G: Umm, but you need to know—you need to have seen the integral, I understand. But, maybe lightening the derivation-load during lectures might help, too.

Paul: Yeah. Well, like, being a teacher and [having taught] labs, like, I know that both of those things you mentioned, it's sort of common amongst all physics teachers…

Student G: Um hmm.

Paul: …because we love…we love the beauty of equations…

Student G: [laughing softly] Right.

Paul: …as you had mentioned the aesthetics of physics.

Student G: Right.

Paul: The beauty of it often trances us into loving, almost with a deep love, the derivations. And then, the labs—often faulty equipment…

Student G: Right.

Paul: …that happens so much with…it's one of the hardest things about teaching labs, because there's…

Student G: Especially on a budget, because…

Paul: Yeah.

Student G: …those lasers I was using are very expensive, I would imagine.

Paul: Yep.

Student G: And, you have to set them up.

Paul: Yeah, and then sometimes things break, and…and…. But, those are—but, that's good [answers], and basically, unless if you have anything else, I guess that concludes our experiment…our…our interview. [laughing]

Student G: I was happy to help.

Interview with Physics Student H (female) at the University of Mississippi (Summer, July 2012, Oxford, MS)

Paul: Do you think physics is an important subject?

Student H: I think that physics is a very important subject due to how other subjects stem from physics, such as chemistry or calculus which are all subjects that many students on this campus are interested in. And so, without physics, all of these students would not have something to be interested in, essentially. So, I think it's a very important subject since so many other things come from it.

Paul: OK. Did you major in physics? Or, what did you major in?

Student H: I am not majoring in physics. I am majoring in chemical engineering, and I am majoring in chemical engineering because you can take the basic principles on chemical processes and apply it to the human body. And, when you apply it to the human body—I want to go into drug design…

Paul: Uh huh…

Student H: …and so, I can take the chemical properties that I learned in all my chemistry classes, and apply those to the drug design, to the body, which those principles I essentially learned in chemical engineering.

Paul: OK. And, similarly—a related question—but as…I guess…as someone…I can usually recognize the people that are actually from the South or whatever or from Mississippi or close to the surrounding area, but would physics even appeal to, let's say, like a female student at a young age? What things would make them maybe not major in physics or choose to major in physics? I guess what I'm saying is, generally females for some reason, it's not a field that they go into a lot, but why might that be? If you had to say…

Student H: I think that in middle school and high school there tends to be a separation between females and males. Females are more scared to answer questions, and therefore fall behind academically. And so, physics is a harder subject, so they feel that they might not be apt to do such a subject. But, I also feel like females—and males as well—may not be prone to majoring in physics because we're not really exposed to the subject that much in high school. I took one physics class, and it was essentially just algebra. You plug in numbers into a formula. And, it wasn't really a true taste of physics or what all you could do with it.

Paul: Right.

Student H: So, I feel like that when girls at a younger age feel that they aren't as intelligent as the other students around them, they're not going to try for a harder subject, for a harder major, as maybe boys do.

Paul: OK.

Student H: That's how I feel.

Paul: OK. That's a good answer. And all these answers, like, I will try to type up the results and maybe find some things that will help people in the future, of all groups, you know. But, whenever you came into the physics class, did you feel well-prepared for the physics class or not?

Student H: Umm, Physics One, I felt prepared for it. However, I didn't feel as prepared for Physics Two—just because it deals with the electric field, and I've never had anything to relate that to. Whereas with Physics One, you take other courses that you can relate those subjects to physics to help you understand it. Whereas with Physics Two, I didn't feel as prepared because I couldn't relate it to anything in my mind.

Paul: OK. Well, what could be done to help students to have a better experience, umm, with studying physics?

Student H: Umm, I know for me, what definitely interests me is when—you know, I said earlier that subjects such as chemistry and calculus derived from physics—that if I understood that when I'm learning this in my chemistry class, it actually comes from this in physics, then that would help me understand more with physics…but also spark my interest more in physics, I guess you could say. So, I think that that would help me. I relate things to learn, so if I could relate "this topic in physics relates to this in chemistry," then my mind could probably wrap around it some more, I guess you could say.

Paul: OK. Well this is, I guess, one last question. I just thought of it, which I thought it might be good. But if you had to say, what is your favorite thing about physics as a student—if you have a favorite? If you don't, that's OK, too. But, if you had a favorite thing about it, what would that be?

Student H: Well, I think…like I just said, whenever students realize that things stem from physics; whenever I'm sitting in class and we talk about a subject, and then I realize that something I learned in my calculus class came from physics (or vice versa); I think that is one of my favorite things, when I can relate those topics to each other…because, I understand it, I guess, and so I already have some experience with that. So, I guess that's one of my favorite things is realizing the connections between the two.

Paul: OK. Well, I thank you for the interview today, and unless you have any further comments, I guess that's the end of the interview.

Student H: Thank you.

Paul: Thank you.

Interview with Physics Student I (female) at the University of Mississippi (Summer, July 2012, Oxford, MS)

Paul: Do you think physics is an important subject?

Student I: I would think that it's important in the development of the world and, you know, everything around us. Umm, I think that the importance of it varies depending on the situation. For example, my grandfather was a civil engineer. And so, for everything he did, it was very, very important. And it was important for the people he interacted with, as well as the people that he built the bridges for; that he built the buildings for; developed the sewer lines for; it was very important. Umm, but for me—as a class, I hold it important purely because it's part of the curriculum…

Paul: Right.

Student I: …not because I'm majoring in physics.

Paul: OK. Well, I assume that your major isn't physics. Am I correct in that assumption?

Student I: Um hmm.

Paul: OK, because that's what you just said, but umm…what reason did you choose not to major in physics?

Student I: Personally, I'm more interested in the biology stuff of the world. I'm more interested in why the body does what it does. I'm actually majoring in exercise science to go to the PT school, so…. I like the physics of the body, not so much the physics of objects.

Paul: OK. OK, well, whenever you came into the physics class, did you feel well-prepared for the physics class?

Student I: I felt like I was more prepared than a lot of others that I'm taking the class with, purely because I had the advantage of taking physics in high school—on top of taking it with a very good teacher.

Paul: OK.

Student I: I know some classes—some people that I've met here—their physics teacher was a coach.

Paul: Um hmm.

Student I: And, their coach couldn't tell them anything. Where my physics teacher had us actually—she had one of those electromagnetic balls—and when we stood on each other, we just stuck our fingers out; and then we grounded ourselves, and it didn't hurt anymore. And so, she could make physics not only fun, but worth learning. Because, we also built rockets. So, I mean, I felt really prepared because I remembered a lot of it.

Paul: OK. Well, what could be done to help students have a better experience with physics—with studying physics or with physics classes?

Student I: That's going to depend on the student, honestly. Umm, I've tried to do that with myself, "How can I make physics more worthwhile to study?" Because, it's a lot of math, and I do not like math. [chuckling]

Paul: Yeah. [chuckling]

Student I: [It's] one of those things I don't do, and I don't like. So, it makes it just tedious for me to study physics. But I feel like if the students can see it as a stepping stone and not just a class, just something—but it will make them better for their job profession.

Paul: Uh huh.

Student I: I think that can make it more worthwhile for students that will actually participate more.

Paul: OK. Well, I thank you for conducting the interview with me, and if you have no further questions or comments, I guess that's the end of the interview.

Student I: Thank you.

Paul: Thank you.

Interview with Physics Student J (male) at the University of Mississippi (Summer, July 2012, Oxford, MS)

Paul: Do you think physics is an important subject?

Student J: I do. Do you want me to explain why?

Paul: Yeah.

Student J: I feel it's really important because, you know, you have biology; and to explain biology, you have to use chemistry; and to explain chemistry, you have to use physics. So, physics explains a lot of the sciences, in my opinion.

Paul: OK. Did you major in physics?

Student J: No.

Paul: OK.

Student J: I like physics. I'm majoring in engineering because I prefer to use the physics to make it, instead of just study and expand on physics.

Paul: OK. Well, what—I'm just curious—like what actually did you major in? I mean, was it civil engineering or…

Student J: Mechanical [engineering].

Paul: Mechanical. OK. Well, I…what would…so basically, if I understand you right—many students choose engineering over physics—but would it be because they don't realize what physics is at an early age? Or, is it mainly that they know, but they just like the applications? Like, how would you say, out of those two? That may be a difficult question.

Student J: I like it because I prefer using the application of it. I like using it. Umm, a lot of people, I believe, don't know exactly completely what physics is or they feel physics is too much for them, such as theoretical physics and stuff like that.

Paul: OK. Well, do you feel that you were well-prepared for your physics class when you came into the class?

Student J: This class, yes sir. I took it at another university, but I dropped it because I couldn't understand the teacher.

Paul: OK. That's alright. And I think that is, you know, sometimes that is an impediment. That's the truth.

Student J: Um hmm. Yes sir.

Paul: Like, many times it helps to have a teacher that at least can really explain things in such a way that you're used to hearing.

Student J: Yes sir.

Paul: That's true. Well, what could be done to help students have a better experience studying physics?

Student J: Umm, well, I had a great physics teacher in high school. He graduated from MIT and all that. And, he always kept our attention. He didn't just explain the physics, he showed us, like, in our everyday lives how stuff worked. And sometimes it didn't work in how we thought it was working. So, it always kept my interest in that.

Paul: OK. Well, one last question that I thought of is: if you had a favorite thing about physics, what would you say, basically? If you don't, that's fine, too. But, if you had something to say that—your favorite thing about physics—what would that be?

Student J: My favorite thing about physics is probably, in my opinion, that we will never completely understand physics entirely.

Paul: Right.

Student J: There's always going to be something new.

Paul: Well, that's true, and that's—I appreciate you for conducting this interview with me, and unless if you have any further comments, I guess that's the end of the interview.

Student J: That's it.

Paul: OK. I thank you.

Student J: Alright. Thank you.

Main Answers from the Interviews with 10 Physics Students (Separated Out Question by Question)

In the following pages, the main answers to each interview question on the student interview form [see *Qualitative Survey Form: (For Interview with Students)* in Appendix C] are shown for each student. The researcher took the interview transcripts, and selected out the main part of each student's answer for the interview questions which were asked of that particular student. So, while the full interview transcripts show the complete context for the various ways the question was asked (or answered), the "main answers" below are arranged in such a way as to show all of the students' main answers (one after another) to the interview questions which were asked to each student. This way, the main answers of the physics students (for each question) can be more easily viewed and compared, side by side.

Main Answers from Interview with 10 Physics Students (Question #1*)*:

(1) Do you think physics is an important subject?

Student A: I would definitely say it's important in terms of using physics; like, you know, most sciences we take in high school and stuff—you never actually get to apply it, and like, figure things out, you know, things that are actually useful. Like, Ole Miss runs a trebuchet competition where you actually get to use physics and apply it. You can, you know, change angles up, and get velocity, and all that. And so, I think physics [is] important in that you can actually apply it to real life stuff.

Student B: I do think it's important. I mean, basically it gives us a look at, you know, why everything around us works. I mean, it gives us answers to why we don't float up in the air; and how light works when you turn on a light switch; and just…I mean, pretty much answers everything about nature and the universe and everything else. It just gives you the key to understand what's going on.

Student C: Yes. I think it's really important because it kind of shows how everything actually works; like, from the little things (like electron level), to like cars, and the whole world; and pretty much, like, the universe and everything, how it all works and came together; and…it's good at explaining everything at a deeper level…than most other courses can.

Student D: I definitely think physics is an important subject. Physics surrounds our everyday life, and is very relevant to everything that we do. But, I mean, I am not one that really likes to partake in physics much. I am a mechanical engineering major. But, of course, physics is very important, and it solves many questions in our daily lives.

Student E: Yes, I think it's important just because you learn, like, how things work, how currents flow. You learn how things work. And, I think that's important to know.

Student F: I think it is one of the most important subjects; because, physics may not provide such a immediate advance in technology, but over time, engineering and, like, engineers, use the knowledge gained through physics to apply to today's technology and to today's society. So, it's a great subject to study just to have a background in it, because it's always good to understand how things work around you—stuff like that, just common sense. But, those of us who want to go deeper into physics and do research and stuff like that, I think it's important…just for future generations.

Student G: I would say that physics is—since it embodies so many subjects in science, it's the basic science. So, if you want to do anything in the field of science (which can encompass everything from auto body repair to, I guess, string theory research), if you don't have a grounding in physics then your education is just lacking. So, from early on, you probably need a grounding in physics, either from your teacher or from some other source. Now, I don't know if things like EMF, or optics, or high-level more difficult things are applicable in everyday life. But for myself—I'm a mechanical engineering major—most topics in physics, if not all, are going to be useful. So, I guess it depends on the context; but I would say that physics is a very important subject, if not one of *the* most important, especially in secondary education.

Student H: I think that physics is a very important subject due to how other subjects stem from physics, such as chemistry or calculus which are all subjects that many students on this campus are interested in. And so, without physics, all of these students would not have something to be interested in, essentially. So, I think it's a very important subject since so many other things come from it.

Student I: I would think that it's important in the development of the world and, you know, everything around us. Umm, I think that the importance of it varies depending on the situation. For example, my grandfather was a civil engineer. And so, for everything he did, it was very, very important. And it was important for the people he interacted with, as well as the people that he built the bridges for; that he built the buildings for; developed the sewer lines for; it was very important. Umm, but for me—as a class, I hold it important purely because it's part of the curriculum, not because I'm majoring in physics.

Student J: I do. […] I feel it's really important because, you know, you have biology; and to explain biology, you have to use chemistry; and to explain chemistry, you have to use physics. So, physics explains a lot of the sciences, in my opinion.

Main Answers from Interview with 10 Physics Students (Question #2):

(2) (a) Did you major in physics? (b) Why or why not?

Student A: No. […] It's a pre-med/exercise science [major], and I'm just using that degree for medical school. […] Honestly, I think it [physics] would have been an awesome major, as far as, like, information-wise and learning. Because, like I said, the MCAT [Medical College Admission Test], that I have to come up taking now in the summer, it actually focuses a large amount on physics. Like I said, you can apply it and stuff. But, in my high school—at least where I went, to a public high school [near the central part of MS]—I know that they didn't, uh…the physics education department was very…just not orderly; didn't focus much; our teachers hardly ever even really went over stuff. A lot of times, we just sat there. […] They didn't emphasize it enough for you to even want to, like, really major in it.

Student B: I really didn't. I major in biochemistry. I've wanted to be a doctor since I could…since I can remember. And, when looking at majors, I just felt like that was the one that was the best designed to take me to med school; because looking at requirements of the couple of schools I wanted, it pretty much followed right along with all of their requirements. I mean, I find physics to be fairly easy as a course. I've never really had any trouble with taking the class. In high school and college, I've been very successful. But, umm, I just—I've always been more interested in chemistry. That's really my main focus in the biochemistry. I'm minoring in chemistry…just because I've always been really interested by, like, lab experiments, especially in chemistry. And also, if I were to major in something else, it would require a lot of extra work; because, there's a lot of classes that wouldn't be on my curriculum that I would still have to take, like, as electives in order to get in…to med school.

Student C: No. I major in biochemistry. […] I'm more interested in, like, the biology aspect anyways, but I didn't want to take just biology…and chemistry. Because, I'm better at those subjects than physics; and because I'm on the pre-med track, and I thought those would gear me more towards doing better on the MCAT and everything. I thought about it [majoring in physics]; especially—I mean, I took it in high school. So, it was really interesting then, too. And I came here, and I'm still really interested in it. But, I'm not good enough in it to actually major [in it]. But, it did interest me—the theory behind everything.

Student D: I mean […] of course I like math, because I'm an engineering major. Umm, I don't know, I just…I am more interested in the engineering aspects instead of the more physics aspects of stuff. Umm, I am in mechanical engineering, so I am interested in, like, factories and different kind of machinery and all that kind of stuff, instead of more like theories…I guess.

Student E: No. I'm majoring in chemical engineering, but I'm going pre-med. So, chemical engineering is more of a back-up. I think I like more of, like, research and hands-on, and I feel like with chemical engineering, you're more of a hands-on, or you can do more of the research, more so than, like, just a physics major.

Student F: I'm not currently majoring in physics; I'm majoring in civil engineering, because I want to pursue a career in the United States Navy as an engineer. And then, after three years of that, I want to go back to graduate school and finish a Master's of Science in physics; and then, possibly a PhD later on down the road. […] When I was eight years old, my dad introduced me to physics—not the typical physics, but more so astrophysics…study of the stars, stuff like that. And then ever since then, I've always been interested in how stars work, how galaxies form, how things work in the universe. And that's what really introduced me to the subject. And that's what I want to get my Master's in, is astrophysics.

Student G: I did consider it. My mother is a physics teacher in high school. Not only was she *a* physics teacher, she was *my* physics teacher. So, I've always felt the influence of science education pretty strongly. But, as it turns out, I'm also—I also joined the military. I'm in Navy ROTC right now. And, the scholarships they have stipulate: to get the full benefits, you need to have some sort of technical major like mechanical engineering. Physics falls into, like, the "B" category, where you might get it taken away if money runs out. So, for security reasons, mostly, I chose mechanical engineering, but I was always leaning towards it because of its practical applications—[which] always attracted me. It goes over much the same subjects; in most campuses, I believe, they have you trained in classical physics; not necessarily just the statics with the beams and all the applications, but they actually have you go through and see the derivations in class—in physics class. And, that's because you need to have appreciation for it, if you ever want to further even the mechanical engineering field. So, I knew all that was going to happen, even if I did mechanical engineering or even something like chemical engineering; they all take physics. So, even though I was interested in the subject, I knew that I could also *not* do physics, and still do it at the same time. Win-win situation.

Student H: I am not majoring in physics. I am majoring in chemical engineering, and I am majoring in chemical engineering because you can take the basic principles on chemical processes and apply it to the human body. […] I want to go into drug design… and so, I can take the chemical properties that I learned in all my chemistry classes, and apply those to the drug design, to the body, which those principles I essentially learned in chemical engineering. [*Note: In the interview with this student, the interviewer did not really precisely ask part (b) of Question #2 from the "Qualitative Survey Form: (For Interview with Students)." The interviewer asked a somewhat related question, but it dealt more specifically with the question of why females do not often choose to major in physics.*]

Student I: [No]. Personally, I'm more interested in the biology stuff of the world. I'm more interested in why the body does what it does. I'm actually majoring in exercise science to go to the PT school, so…. I like the physics of the body, not so much the physics of objects. [*Note: The interviewer asked the first part, in other words part (a), of Question #2 to this student in a slightly different and more indirect way than it is listed* *on the interview form, "Qualitative Survey Form: (For Interview with Students)." So, although the student did not technically answer "No", the student made it clear (within the context of the interviewer's question) that she was not majoring in physics. See the original interview transcript for the precise wording of the question to the student.*]

Student J: No. I like physics. I'm majoring in engineering because I prefer to use the physics to make it, instead of just study and expand on physics. [*Note: The interviewer did not precisely enough ask the second part, in other words part(b), of Question #2, as shown on the Interview Form titled "Qualitative Survey Form: (For Interview with Students)." However, the student still somewhat answered part (b) in his answer to part (a) of Question #2.*]

Main Answers from Interview with 10 Physics Students (Question #3):

(3) Do you feel that you are well-prepared for your physics class?

Student A: From the way that Ole Miss teaches it, I came in—I don't feel like I was prepared. No. Not for physics. But, I mean, I did fine in it. I made an "A-minus" in the first one. It's very—I mean, it's hard at Ole Miss. But it was only because I had to work so much harder to catch up, I felt like; because the high school, in my opinion, doesn't prepare you enough for the college-level physics—what physics really is. But, yeah, it—I don't think I was prepared, like I should have been, coming in.

Student B: I do feel like I was pretty well-prepared. Umm, I am taking the algebra-based [physics course], but I've actually had all the way through Cal Four [Calculus IV]. So it's kind of—there were a lot of stuff that I kind of had to go back to that I was like, "OK, I've got to remember how to do basic algebra. Because, it's been so long since I've done regular algebra." But, I did take physics in high school. And, I felt like physics—the first semester class—was pretty much right along with what I remember learning in high school, with just a little bit more in-depth on the topics. So, I felt like I got a good base in high school, and it helped me to really be successful when I came here and was taking it over again. [*Note: The interviewer asked the interview question to Student B in the past tense form, "Do you feel that you* <u>*were*</u> *well-prepared for your physics class?"*]

Student C: I do. Well, Two-eleven [211, calculus-based Physics I] was more of, like, the gravity and all that stuff. Two-twelve [212, calculus-based Physics II] is the more electron and the magnetism part. So, I felt better for Two-eleven, because to me, it was easier to grasp the concepts. For Two-twelve, I still feel prepared; but it's harder…because it's smaller.

Student D: Umm, my physics class is a difficult class. I try to study in and out of class. Very occasionally, I try to, you know, do my homework, you know, do my studying, you know, my good bit. I feel that I am not, I guess you could say, as smart or as prepared (or whatever kind of word you would want to use) as other students in the class. However, I mean, I feel like I am doing decent, and I just don't see myself going towards that career path…in future years.

Student E: Umm…well…took it in high school, but it was a lot. Like, I took the trig-based in high school, so coming in and doing cal-based physics was a whole new thing. Where I knew what a current was, or I knew the definitions of something; the actual way of deriving the formulas and using them, and putting them in the concept, was a lot more difficult than my high school course. So, it was a "so-so" prepared.

Student F: Yes; um, I had physics when I was in high school, my senior year. So, when I had Physics One last semester, I felt like I knew most of it already. And so it was more of, uh, kind of a brief overview of what I already learned in high school. And so, I felt pretty prepared. Physics Two that I am taking now, not so much; because we didn't cover it in high school. But I feel like the background that I got last semester in Physics One really prepared me for…for Physics Two. So, yes. [*Note: The interviewer asked the interview question to this student in the past tense form, "Whenever you came into your physics class, <u>did</u> you feel well-prepared for the physics class?"*]

Student G: I think I was. But, I think I am the exception and not the rule. Like I said, my mother taught the physics class, and I had a very early exposure to science classes because of my parents. They both valued science education very highly. Reading and math—I started to reading at a young age, and I did…I started doing math. But, accelerated programs were the reason that I moved to the specific spot in [a state in east/central USA] that I moved to. My parents were the ones that definitely got me into it earlier. So, I was prepared better than I think most of my peers are. I was the…I'm the one that everyone's [asking], "Hey, do you know how to do this optics problem? Is the radius of curvature here positive or negative?" I was the person, because I had seen it all before in AP Physics—most of it. I shouldn't say "all of it", because the things like, uh, E-waves and things, and E and B fields, I hadn't seen before—some of the EMF stuff. But, kinematics—I was doing that when I was fifteen years old. […] I think, comparatively, I was much more prepared than most people are. And, I'm thankful for that, because this…this was not—uh, Physics Two was not an easy course to go through. [*Note: The interviewer asked the interview question to this student in the past tense form, "Do you feel that you* <u>*were*</u> *well-prepared for your physics class?"*]

Student H: Umm, Physics One, I felt prepared for it. However, I didn't feel as prepared for Physics Two—just because it deals with the electric field, and I've never had anything to relate that to. Whereas with Physics One, you take other courses that you can relate those subjects to physics to help you understand it. Whereas with Physics Two, I didn't feel as prepared because I couldn't relate it to anything in my mind. [*Note: The interviewer asked the interview question to Student H in the past tense form, "Whenever you came into the physics class,* <u>*did*</u> *you feel well-prepared for the physics class or not?"*]

Student I: I felt like I was more prepared than a lot of others that I'm taking the class with, purely because I had the advantage of taking physics in high school—on top of taking it with a very good teacher. I know some classes—some people that I've met here—their physics teacher was a coach. And, their coach couldn't tell them anything. Where my physics teacher had us actually—she had one of those electromagnetic balls—

and when we stood on each other, we just stuck our fingers out; and then we grounded ourselves, and it didn't hurt anymore. And so, she could make physics not only fun, but worth learning. Because, we also built rockets. So, I mean, I felt really prepared because I remembered a lot of it. [*Note: The interviewer asked the interview question to this student in the past tense form, "Whenever you came into the physics class, did you feel well-prepared for the physics class?"*]

Student J: This class, yes sir. I took it at another university, but I dropped it because I couldn't understand the teacher. [*Note: The interviewer asked the interview question to this student in the past tense form, "Do you feel that you were well-prepared for your physics class when you came into the class?"*]

Main Answers from Interview with 10 Physics Students (Question #4):

(4) What could be done to help students have a better experience with studying physics?

Student A: Honestly, I think [that in high school] they need to teach it earlier. And, they need to have more courses and curriculum in physics; because, at my high school, you didn't even have to take it if you didn't want to; you didn't have to take it at all. But, it was, like, voluntarily; you could take it; and it was only one course. If you wanted to, you could only take basic Physics One. And it's like, if you wanted to take more to prepare yourself even more, they didn't even offer it. And, this was at a, I mean, like a Five-Star school, too—like highest test grades in Mississippi and all that—and they still only have one physics course. So…look how the other high schools could be. They probably don't even have a physics [course]—a lot of them. Umm, [at the college level] I like it…[at the] college level, I mean, they teach it pretty well, except for, I don't think they focus on enough concepts. I think it's so much math, and it's so much focus on the word problems, that they don't explain what this means. […] So, but other than that, I think college-level teaches it pretty well—from, at least from being at Ole Miss.

Student B: Well, I mean, I think that physics is just like any other math class, really. Like, it really just takes the time to sit down and really work with the material; because if you don't work with it, you're not ever going to really learn it. And, I mean, you can work it once or twice and have the right answer, and know that one type of way to do it; but that doesn't necessarily give you the entire understanding of how it is. And it just takes a lot of, you know, sitting down working a lot of different types of problems, and really just, umm…just making yourself do the work; because that's really what will help you be the most successful; because it gives you a way to look at it to where you understand why the problem is worked this way and how the math is done, instead of just how to plug numbers into a formula. Because that really helps you—because then it doesn't matter what kind of problem they give you, you're going to know how to work it…if you get that full understanding.

Student C: Umm…well, there's no way to make it easier, but, umm, I guess just…to me, it'd make more sense if there was a theory-based class that went along with the math part. Like, there's a physical science class here that I think is a lot of the theory behind it. But, I think they should also have to learn the math part, but maybe like a recitation or something that would help them understand both concepts. Because, putting them together is difficult—because, I'm better at understanding the theory than I am with the math part.

Student D: Umm…I would, I guess, say…I don't know, I guess try to have outside tutoring sessions or something. I don't really know. I mean, like…I mean, if they don't necessarily like studying, it's kind of difficult to push someone to do that. I mean, I could only just say, like, just keep pushing somebody; and just keep them going, I guess; and just try to get it in, like, their head or something. I don't know.

Student E: Umm, one of the things that we've done this summer is: we've always had groups. And, every time we do something, we have a group together; and we're studying physics or going over this. And it's a lot better than trying to sit down and study it by yourself, because you can talk out a homework problem with someone else and come up with the solution. And, it's easier to talk to someone than sit down and just try to look at your book and figure out the answer; because when you have someone else working, it really makes it easier of…getting it right, and just seeing…like, they might understand it, and you don't, and they can explain it to you. So […] studying with people is always better for me.

Student F: From what I've seen in the past year—studying physics here—is that a lot of kids just have a bad experience in the classroom that makes them not want to go home and study. It just makes them not want to continue with physics, because they had a bad experience with a teacher or with the subject. And so I think, you know, if teachers can keep their students interested in the course, keep them from sort of wandering off mentally in the course, kind of keep them involved in class, don't let them drift off; then that may help. Because, I feel like a lot of kids just have a bad experience with their teacher or just with the course, and that keeps them from wanting to move on with the subject.

Student G: That's…that's definitely a hard question. Umm, what I absolutely despise in my entire education is night labs. Anything after about six o'clock in the afternoon…six o'clock in the afternoon you've got a two-hour class to look forward to, where you're watching a weighted turn-table go around for thirty seconds at a time for about an hour. That's…that is the most depressing thing that I've ever done in my whole life. […] Some of the experiments are very interesting. But, sometimes, they could be sped up, or conceptualized better, or faster, or something. Uh, some of the subjects…some of the concepts, uh, don't necessarily need to have labs attached to them, I don't think. Umm…I know that not all of them do, but that would go a long way towards increasing interest in your classes, is if the labs were more…well, were more interesting, umm, the demonstration of the concepts are better. Now, a lot of times, what will ruin a lab more than anything else is faulty equipment. And, you have to make up your values. And the TA doesn't know what to do. You don't know what to do. You don't know what it's supposed to be. So, if equipment was tightened up and always working fine—which, I know, is a perfect world, but—that would make the labs faster, more enjoyable, and they would hammer the idea home much better. […] As far as teaching goes…I have a particular professor that's very interested in the mathematics; and he derives the equations for us, which is nice for some people. But, I think for some people, he loses them; and they just kind of give up. And when you actually see: you don't always need to take a double integral over a closed surface to find the flux over something—uh, the change…the change in a magnetic field in something. Sometimes, you just need to remember how to do it. This is a…a sphere has a certain one, and a ring, and all these have certain equations for them. And, that's the practical side of it for passing your tests. Umm, but you need to know—you need to have seen the integral, I understand. But, maybe lightening the derivation-load during lectures might help, too.

Student H: I know for me, what definitely interests me is when—you know, I said earlier that subjects such as chemistry and calculus derived from physics—that if I understood that when I'm learning this in my chemistry class, it actually comes from this in physics, then that would help me understand more with physics…but also spark my interest more in physics, I guess you could say. So, I think that that would help me. I relate things to learn, so if I could relate "this topic in physics relates to this in chemistry," then my mind could probably wrap around it some more, I guess you could say.

Student I: That's going to depend on the student, honestly. Umm, I've tried to do that with myself, "How can I make physics more worthwhile to study?" Because, it's a lot of math, and I do not like math. [It's] one of those things I don't do, and I don't like. So, it makes it just tedious for me to study physics. But I feel like if the students can see it as a stepping stone and not just a class, just something—but it will make them better for their job profession. I think that can make it more worthwhile for students that will actually participate more.

Student J: Well, I had a great physics teacher in high school. He graduated from MIT and all that. And, he always kept our attention. He didn't just explain the physics, he showed us, like, in our everyday lives how stuff worked. And sometimes it didn't work in how we thought it was working. So, it always kept my interest in that.

Commonly Mentioned Themes from the Main Answers of the 10 Physics Students who were Interviewed

Table 369

Commonly Mentioned Themes from the Interview with 10 Physics II Lab Students at the University of Mississippi

Do you think physics is an important subject? Explain.
**Yes (10)
**Physics is important because it helps us understand nature and the universe; it allows us to understand how things work. (5)
**The knowledge gained through physics can be applied by engineers to technology and society; physics can be applied to things in real life. (5)
**Physics is a great subject to have a background in; physics is important since so many other subjects stem from it (4)

2. (a) Did you major in physics?
**No.(10)
**No, but I plan to get a Master of Science degree in physics later, and possibly a PhD some time after that. (1)

2. (b) Why or why not?[a]
**I felt that another major was better designed to help me get into medical school than a major in physics would be. (2)
**My engineering major fits well with my military career plans.(2)
**I am more interested in another subject. (3)
**I am more interested in biology. (2)
**I am more interested in applications rather than theories. (2)
**I am attracted to the practical applications associated with an engineering major. (4)

3. Do you feel that you are well-prepared for your physics class?[b]
**Yes.(6)
**No.(1)
**Somewhat.(3)
**I felt like I got a good background in physics due to my high school physics class. (4)
**My high school physics class prepared me especially well for the first-semester of my college physics class. (3)
**I felt more prepared for the first-semester physics class than I did for the second-semester physics class. (5)
**I was more prepared than I think many of my peers are. (2)
**I found college-level physics to be more difficult than what I was prepared for by my high school.(2)

4. What could be done to help students have a better experience with studying physics?
**At the college level, there is not enough focus on the concepts which are behind the math. (3) **It would probably help if teachers can push students in such a way as to motivate them to keep going and to stay involved in the course so that they do not drift off mentally and lose interest in the course. (2)

Note. Ten different physics students, at the University of Mississippi, were interviewed for this research project, and the common themes of their main answers to the interview questions are shown in the above table. By "common themes", the researcher means the themes which were mentioned by more than one student. Using the text from the "Main Answers from Interview with 10 Physics Students" (for each of the four questions), the researcher picked out the common themes which were mentioned. After each common theme which is listed, the number of students who mentioned the theme is shown in the parentheses. Except for a few special cases needed for comparison purposes (such as some Yes/No questions and short answers), the researcher did not list themes that were mentioned only once (in other words, mentioned by only one student). If one wishes to see these individual answers in more detail, one can read the "Main Answers from Interview with 10 Physics Students" (for each of the four questions), or one can read the full interview transcripts.

[a]In some cases, the student gave the answer, or part of the answer, to Question 2(b) in his or her answer to Question 2(a). In such cases, the researcher included these answers within the analysis for Question 2(b). Also, there were a two cases (Student H and Student J) where the researcher asked Question 2(b) in a way that was worded too differently than the way Question 2(b) was worded on the *Qualitative Survey Form: (For Interview with Students)*. Thus, the researcher did not include the answers from those parts within the analysis for Question 2(b). However, in one of those cases (Student J), the student somewhat answered Question 2(b) in his answer to Question 2(a). Thus the researcher did include that part of the student's answer within the analysis for Question 2(b).

[b]For the majority of the 10 students who were interviewed, the researcher actually asked this question (Question 3) in a past-tense form during the flow of the interview. For example, "Do you feel that you were well-prepared for your physics class?" The researcher thinks that this could especially affect the interpretation of the "Yes/No/Somewhat" answers, but possibly some of the others (shown in the analysis for Question 3), too. If one wishes to see the precise wording of each question as it occurred during the flow of the interview and how each student answered it, one can review the full interview transcripts.

Transcripts of Interviews with 12 Physics Professors at the University of Mississippi (in Oxford, MS)

In the following section of the dissertation, the researcher has included the full transcripts of the interviews which the researcher conducted with 12 Physicists (labeled here as “Physics Professors”). The term “Physics Professor” or “Professor” or “Physics Instructor” could include Professors, Assistant Professors, Associate Professors, Research Physicists, retired Professors (Emeritus), and other such designations which might officially be different than the official “Professor” title as designated by university administration officials. The physicists who were interviewed have taught classes or done research (or both) at the university level.

As far as the researcher is aware, the entire sample has advanced graduate degrees—doctoral degrees. Also, the universities included in this research project included the University of Mississippi, Mississippi State University, and the University of Southern Mississippi. Thus, individuals from all of those universities were involved in interviews or the surveys. However, these twelve professors (in the transcripts of the 12 physicists which are shown directly below) presently work or once worked at the University of Mississippi in Oxford, Mississippi.

The researcher endeavored as much as possible to preserve the anonymity of the individuals in the interviews. However, it seems impossible to achieve a perfect removal of indentifiers when such detailed interviews are conducted—especially when the sample sizes are fairly small. Overall, the identities should have a high degree of anonymity to everyone except those people who personally know the life details of the physics professors or research physicists who were interviewed. In general, the researcher feels that there is only a minimal amount—if any at all—of information in these interviews which might be considered to be of a sensitive nature. The researcher endeavored to conduct interesting interviews, but in such a way that they could be included in a biography or a newspaper article viewable by the general public. Nevertheless, the researcher made an attempt to remove the names of the physicists, as well as many other obvious identifiers, when possible.

In total, the researcher interviewed 17 physicists who presently work or have worked in the past at universities in the state of Mississippi. The sample of 17 physicists includes the 12 physicists (whose interview transcripts are shown directly below) in this part of the dissertation plus the 5 native Mississippian physicists whose interview transcripts follow these in a latter part of the dissertation. The 17 physicists who were interviewed for this research project presently work (or once worked) at the University of Mississippi; or at Mississippi State University; or at the University of Southern Mississippi. However, the 12 interview transcripts directly below come from interviews with physics professors or physics researchers who presently work (or once worked) at the University of Mississippi.

Interview with Professor #1, Physics Professor at the University of Mississippi (Summer 2012)

Paul: In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places?

Professor #1: No, I don't think so. In general, they are not really that well-prepared. One reason for that is that in other countries, I mean, there is already some pre-selection of the students who come to the university. Whereas, here we don't have that kind of a pre-selection. OK, anybody from the high school who comes can come into the university and take some physics courses here.

Paul: Yes sir.

Professor #1: And so, they don't have to be prepared for physics, in that sense.

Paul: OK. In general—and this is a similar question, and it may have the same answer—but, how do American students compare with international students, in your opinion? And, if there is a difference, what are the reasons for these differences?

Professor #1: I think the international students who come here…they are, you know, they have come after some sort of a competition. So, they are some of the better students.

Paul: Yes sir.

Professor #1: Whereas, the American students here are just a general batch of students, not necessarily the top of the class. So, the foreign students who come here tend to be a little better than the American students, in general. But then, of course, the foreign students will be a small minority.

Paul: Yes sir.

Professor #1: And, you will always find American students who are as good as the foreign students.

Paul: Right.

Professor #1: A few American students will be as good or even better than the foreign students.

Paul: But, it seems like this selection process is an extra factor that helps, like, in your opinion, maybe…maybe many of the international students have gone through very much of a selection process…

Professor #1: Process. Right.

Paul: …earlier.

Professor #1: Right.

Paul: OK.

Professor #1: That's right.

Paul: Do economic factors play a large part in students choosing to pursue a career in physics?

Professor #1: Well, economically, physics is really not that attractive. So…[laughing]

Paul: Yes sir. [laughing]

Professor #1: …so, I don't think that people come to physics for economic reasons. So, I do not know—in our days, when we were studying physics, physics was not only economically interesting, but physics was, by itself, very, very exciting and very interesting.

Paul: Yes sir.

Professor #1: Now that aspect has…physics is still interesting, but it is not as exciting as it was in the sixties or [early?] fifties. And, economy-wise, I think the business MBA students and so on, they get better jobs than physics people. The exciting fields, these days, seem to be biology, molecular biology, and information science…and so on.

Paul: Yes sir.

Professor #1: So, that's where the real intellectual excitement is. And so, probably, I think my, uh, brighter students might be going in those fields rather than in physics.

Paul: OK. Well, one thing that I have often wondered about is exchange rates, and this is a topic I've rarely seen brought up about economic factors, but…let's say—and I don't know if it has any impact—but, let's say an American student…let's say $20,000 has a certain value—and it's good to get through school—but, let's say, to a student from another country, the same $20,000 may be worth much more…

Professor #1: Sure.

Paul: …if they carry that back to their country.

Professor #1: Sure.

Paul: And, I was wondering if maybe that very factor makes physics more appealing to very intelligent foreign students.

Professor #1: Sure. Oh yes. It is definitely…I mean, that that exchange rate plays a role; but, as I said here, it is not just confined to physics…foreign students come here, some of them in chemistry, some of them in physics, and so on. And, when they graduate, they will get a job, and they will get, more or less, equivalent pay. Maybe some more in some other fields than in physics; or, sometimes more in physics than in some other fields.

Paul: Yes sir.

Professor #1: And so, yes, the money which they might have saved might be important to them…might be important to the students. Definitely.

Paul: And, the reason I thought about it…because for many Americans, to have a family and to be a physics student as a TA is almost…very difficult…

Professor #1: Difficult.

Paul: …without going into great debt.

Professor #1: Um hmm.

Paul: But I was wondering if—and I know it's hard also for international students…

Professor #1: Yes.

Paul: …and they do a very good job of being very motivated…but I had just wondered about the exchange rates, in the sense if it was possibly more possible for an international student because the money could be carried home where it was worth more—but I don't know that.

Professor #1: Oh, no, I don't think that really is the…that really doesn't work that way. I think these Indian students generally tend to have a smaller debt than their American counterparts.

Paul: Right.

Professor #1: Firstly, because they really do not have any access to loans…

Paul: Right.

Professor #1: …which the Americans will have.

Paul: Many loans. [laughing]

Professor #1: [laughing] And, they won't have, for example, a guarantor who will support them.

Paul: Exactly.

Professor #1: And, similarly, they cannot get loans—loans are not that easily available back in the countries. And so, for that reason, they are not really that much in debt. So, they have to rely on scholarships here. And for that, of course, they have to—

scholarships are work—so they have to work on campus to support themselves…and…or excel in the field and get some scholarships.

Paul: Yes sir.

Professor #1: Or, of course, cut down on weekend expenses. [laughing]

Paul: Exactly. And, maybe—I'm just thinking, this may be wrong—but maybe they have learned, you know, they have learned from their own country how to live maybe more…more cheaply without…

Professor #1: Yes.

Paul: …like the secrets of living without going into debt…

Professor #1: That's right.

Paul: …because, debt can be difficult. [laughing]

Professor #1: Difficult. Right.

Paul: Well, in your opinion, what could be done to make the Mississippi education system better for producing skilled mathematicians and skilled scientists—if anything can be done?

Professor #1: Sure. Sure. I think this can be done…always. I mean, I think all the time we are trying to improve the situations in the schools.

Paul: Yes sir.

Professor #1: We have been trying to increase the facilities which are available in the schools.

Paul: Yes sir.

Professor #1: Most of the schools have, now, access to computers and also to internet.

Paul: Right.

Professor #1: And so, I think these schools—my guess is, I have no first-hand experience in this—but my guess is that schools must have been improving over the last twenty years or so…

Paul: Yes sir.

Professor #1: …definitely over the last twenty years, the schools must have been improving.

Paul: Yes sir.

Professor #1: So, the thing is, of course, to get more qualified, trained teachers who are really interested in bringing up the standards and interested in the students themselves, bringing up their standards.

Paul: Yes sir.

Professor #1: And, of course, in the states, it's taking…appreciating the efforts of these teachers so that the pay is such that these teachers can live with some dignity.

Paul: Yes sir.

Professor #1: And so, the two things go together, I mean, the teachers don't get paid well, then they cannot survive. Life is anyway hard in this school, and if the pay is also not good, then the teachers—good teachers—will not stay very long.

Paul: That's true.

Professor #1: So, both the things, I think: the teachers have to work, and the states have to take care of their teachers. So, I think if you do both…and, I think…that things are happening, good things are happening, in both directions. That's what my reading seems to be…

Paul: OK.

Professor #1: …that the states are trying to increase the teachers' pays; and, more and more teachers are becoming aware that they have to really put in greater effort and greater dedication to bring up…you know, to their own work to improve the lot of the students.

Paul: Yes sir.

Professor #1: So, I think things are happening in both directions—good things are happening…

Paul: OK.

Professor #1: …from both parties.

Paul: OK. Thank you.

Professor #1: Um hmm.

Paul: The last few questions are more about your own interests in physics so that possibly future students may…may be able to learn from, you know, your experience—or commonalities between physicists—about what gets people interested in physics. So, when did you become interested in physics?

Professor #1: I was actually still in high school when I got interested in physics. One main reason for that is that there was a very good professor in the college, and he used to give…he was very interested in the subject—gave very nice lectures—and even though we were in high school, we attended some of his lectures; and we liked those.

Paul: Yes sir.

Professor #1: And then, of course, when we came to big college then we attended his classes.

Paul: Um hmm.

Professor #1: And, he was a very inspiring teacher, and that really made the difference. The other thing was that my father had a nice library, and we had some nice books.

Paul: Yes sir.

Professor #1: So, if you have an access to a nice library—you don't have to go to your father's library, in your case—but here, I think most of the schools have good libraries, most of the towns have good libraries…

Paul: Right.

Professor #1: …which contain some very nice science books, and not only books, but videos that are very well and so on. So there are no lack of good material…

Paul: That's true.

Professor #1: …on science. And so, if there is a enthusiastic librarian who takes interest in young kids, shows them around, and, you know, takes interest in the kids, [saying] "Hey, why don't you look at these things? Why don't you look at these things?"…

Paul: Yes sir.

Professor #1: …and once, of course, the spark is ignited, then, of course, the children really work by themselves.

Paul: That's true.

Professor #1: So, a enthusiastic librarian and enthusiastic teacher really makes a very big difference in sparking the interest of the students, not only in physics, but in all walks of life.

Paul: Yes sir, that's true. Like the…that's the importance of teachers.

Professor #1: Yes, that's right. [It] makes a big difference. I mean, they change the whole attitude towards life.

Paul: That's true. What were the important factors that allowed you to be successful in physics?

Professor #1: Well…I mean…that's hard to say. I mean, partly just luck. I guess you work, and you find that you are able to cope with whatever is required. And, it is not really guaranteed that you will be able to cope. I mean, you find out; you work hard, you take exams, and maybe if you are able to solve the problems, you will succeed. If you are not able to solve the problems, you are out of the system. [laughing]

Paul: That's true. [laughing] So, you were pretty much able to make it?

Professor #1: And every time you feel that you are barely able to make it, you know, just go over the [laughing]…over the bump.

Paul: That's true.

Professor #1: Yeah. And just slowly learn a little more, learn a little more, and…and made it through.

Paul: Yes sir.

Professor #1: And so…yeah, I mean, it was…I never found things easy at any stage. I had to work, and I was never very confident that I definitely know this or something.

Paul: Yes sir.

Professor #1: Never made a hundred in any class or something like that.

Paul: Yes sir. Well, what would you say to a young student who was thinking about majoring in physics? What would you say about that profession as far as the drawbacks—the advantages and the disadvantages of the physics profession?

Professor #1: I think I would say that it's a very, very exciting field, even now.

Paul: Um hmm.

Professor #1: But, it is still the basic science which allows you to get an appreciation and understanding of almost everything else in the world. So, physics is the science that underlies all the other disciplines of the world. And it gives you sort of a systematic, organized way of thinking—which, again helps you to see what is happening around the world in a…in a more clear perspective…

Paul: Yes sir.

Professor #1: …than the other fields.

Paul: OK.

Professor #1: So, I think that's a…physics is still quite an exciting field.

Paul: Yes sir. OK, well…is there…is there anything else that you would like to say about physics, in general, or physics in Mississippi? Any other comments that you may have?

Professor #1: I've been here, you know, I've spent about fifteen years in Mississippi. And, I have seen this department sort of continue to grow. And, it has participated in two—of course in many, many very exciting experiments—but, in two experiments in which Nobel prizes were involved, and our people were involved in those.

Paul: Yes sir.

Professor #1: We have, of course, the finest acoustic center. Now, unfortunately, I saw that it went…when I came here it was just starting, and then it became very, very, extremely active.

Paul: Um hmm.

Professor #1: And, then Professor Bass passed away, and now it is sort of slowed down a little bit. But, it may come up again. But, that is the other field which was extremely active, and I was very happy to see those things.

Paul: Yes sir.

Professor #1: So…yeah…I mean, there are…I'm not very familiar with the work in Starkville or in Hattiesburg—I know some people there in Hattiesburg who do excellent work in chaos and all that. They hold some international conferences. And so, people do very, very interesting work here.

Paul: Yes sir.

Professor #1: Yeah. And, they…they continue to. I mean, the university, itself, has grown very nicely; and, the campus has become very beautiful under Dr. [name omitted].

Paul: Yes sir.

Professor #1: And, the department here continues to grow. We didn't have any gravitational research. Now, we have one of the largest groups in the country working here.

Paul: So, it seems like we're growing! In many areas! [laughing]

Professor #1: [laughing] Many areas. Yep. Young people in the field.

Paul: Yes sir.

Professor #1: You know, so that's a nice thing to do.

Paul: OK. Well, I thank you for the interview, and…

Professor #1: Sure! Thanks.

Paul: …and that will help Mississippians as they try to become better physicists in the future.

Interview with Professor #2, Physics Professor at the University of Mississippi (Summer 2012)

Paul: Are Mississippi students as well-prepared for graduate-level physics courses as students from other places?

Professor #2: Probably…the ones that actually get admitted; and I don't know all about the students that don't get admitted. So, the admissions committee looks at student applications and decides who to admit. And, then I just see them in class and in the department and giving talks about their research. So, we don't actually have lots of students from Mississippi. I don't know if that's because they're not well-prepared, or because they—if they are well-prepared—they might want to go somewhere else. But the ones that we've had have been reasonably prepared, I think.

Paul: OK. This is a similar question, but…in your experience, how do American students compare with international students, as far as you can tell? And if there is a difference, what may be the reasons? And, if there is not, I guess it's not really a valid question.

Professor #2: I would say that the American students and the international students are comparable in the following way: there are some good ones in each group, and there are some others that aren't as good in each group. [laughing softly]

Paul: OK. That's…that's…OK. Well, do economic factors play a large part in students choosing to pursue or not pursue graduate studies in physics? And, do these factors possibly differ from country to country?

Professor #2: Umm…I don't really know. No one has ever come to me and said, "I chose to study physics because I think it's the way to make a lot of money."

Paul: Right.

Professor #2: Umm…on the other hand—so I guess I don't know of any economic motivation. I think most students that are studying physics—my guess is—think that they'll get a reasonable job, but they're studying physics mainly because they like it and they think that they can get a reasonable job. I mean, you might like to eat ice cream all day, but…

Paul: Right.

Professor #2: …that won't lead to a good job.

Paul: Right.

Professor #2: So, I guess I think economics is a secondary factor in choosing to do graduate study in physics.

Paul: OK. Well, what could be done to make the Mississippi education system better for producing highly skilled science and math students, if anything can be done?

Professor #2: That's a difficult question. I don't really know significant details about the "K through twelve" education in Mississippi. I know that physics education, in that range, tends to be weak across the state, although there are definitely some really good teachers in various schools. But, having a more qualified physics high school and middle school teachers would be good. I think students that are eight to ten years-old are often quite interested in physics; and, I don't know if we're doing a good job of engaging, uh, helping them explore physics at that age. I think it would be a good thing—eight to twelve to fifteen; pre-high school, I guess.

Paul: Yes sir.

Professor #2: And…but, I do think that a good physics teacher in high school would also help. Math-wise, to be able to do physics, you have to have math skills; and you need to be quite comfortable using math to do things, and so the more, the better.

Paul: Um hmm. OK. Well, these latter questions are mainly dealing with personal motivations for physics; and, it helps…it could help future physics majors or future researchers understand better why people choose physics as a career or maybe as a major. But, when did you become interested in physics?

Professor #2: Pretty young; maybe back as young as twelve, or it might have been sooner, I don't know. I didn't know it was physics; it [was] just science about how things worked in the world that we live in. But, we did do some things in my pre-high school classes that were physics—even if it wasn't called physics—which I found especially interesting. I didn't take physics in high school, because I knew a physics professor that told me that the high school physics teacher in my school didn't really have any background in physics at all, and thought that it might be a mistake. So, I didn't. And, I didn't have any regrets about that. But, I think the advice would have been the opposite if this professor had thought that the high school physics teacher was good; I feel certain I would've been advised to take that class.

Paul: Yes sir.

Professor #2: So, anyway, I would say it was pretty young for me—at least as young as twelve and maybe back younger than that…I don't remember very well.

Paul: OK. Well, at what age—if you remember—at what age was it when you began to say, "Well, I think I actually want to pursue a career in physics. I want to go this route as a career."? Do you remember what age you were at that time?

Professor #2: Yeah. I was in college. Somewhere in my second year of college, I decided that I was better suited for physics than for some other things that I at least thought about doing.

Paul: Um hmm.

Professor #2: And…and I enjoyed it; but, there were a number of things that I enjoyed doing; but I decided eventually that some of those things that I enjoyed doing, I wasn't all that good at; so…[laughing softly]

Paul: Right. [laughing softly]

Professor #2: …so I should stick with something that I was better at, which was physics.

Paul: OK. Well, what were the important factors that allowed you to be successful in physics?

Professor #2: Hmmm…that's a tough question. Self-examination is not so simple. Probably the most important thing was that I liked doing it. So, I was willing to spend time on it.

Paul: OK. That's a common thing that many professors—I've found that it's very common, just the love of the subject. OK. Well, the last question is about whether the physics profession represents a profession in which Mississippi students can realistically obtain a well-paying job with satisfying job conditions. So, what would you say to a young student that was interested in going into physics as a profession? What would be the words—I know I asked that in a rather weird way—but what would be…how would you advise him if he's considering things like job conditions, just many factors he's considering?

Professor #2: I guess I would say sort of what I said just a moment ago: if you really like doing it, then you'll enjoy your work.

Paul: Um hmm.

Professor #2: And…uh…now I like doing physics, so I like the job that I have. There are other physics jobs that are not teaching, that I'm sure are equally—or maybe even more rewarding than the one that I have. I think people ought to do what they like doing, as a profession, because they're going to do it all the time. And, if you don't like what you're doing, it seems like you've made a mistake.

Paul: Right. OK. Well, I thank you for helping me with this interview, and unless if you have any further things you would like to say about physics, I guess that's the end of the interview.

Professor #2: OK. Well, I hope it helps.

Paul: OK. Well, I thank you.

Interview with Professor #3, Physics Professor at the University of Mississippi (Summer 2012)

Paul: In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places, from what you can tell?

Professor #3: Well, not quite as well-prepared, but they can do good. They can do good.

Paul: OK...alright.

Paul: In general, how do American students compare with international students, in your opinion? And, if there is a difference…if there is one…what may be the reasons for these differences—if there are differences?

Professor #3: OK. We get quite a few international students wanting to go into physics, uh, but I think that the main difference isn't necessarily that they're better in physics. But…they don't have the interpersonal skills to get into business, for example. So they wouldn't necessarily be able to become MBA majors. Whereas American students can get into becoming an MBA major, get into law, get into a whole variety of fields…

Paul: Yes sir.

Professor #3: …well-paid fields.

Paul: Um hmm.

Professor #3: And so, I think they tend to do that.

Paul: OK. Well, and that kind of leads into a good question: do economic factors play a large part in students choosing to pursue graduate studies in physics? And, how do these differ from….

Professor #3: Well, the strange thing about physics here, if you come and major in physics, you'll probably get out of here without any debts.

Paul: Which is good.

Professor #3: Because, there's actually support, even some at the undergraduate level with scholarships. Some…uh, there might be some teaching assistant openings even for juniors and seniors.

Paul: Yes sir.

Professor #3: Whereas in other fields, you actually wind up with owing bills after the end of your four years.

Paul: Right.

Professor #3: So, I think the economic factors are sort of…geared even a little bit in favor of physics.

Paul: Right.

Professor #3: At least for your first four years, you know.

Paul: Yes sir. OK. Well, what could be done to make the Mississippi education system—if anything can be done—what could be done to make it better for producing highly skilled science and math students?

Professor #3: OK, well, we're having some impact on it, and we'd like to have more impact on it. But, it's a question of…not too many of our high school teachers have a bachelor of science degree in physics or chemistry or biology…or a master's degree in any of those fields. So, I think it's a question of getting more people like that. Also, in our community colleges—getting people teaching the courses, you know, that have actually majored in these topics. And, we're having somewhat of an impact on that. Well, we sent…you took some courses here and went off and were teaching at community college…

Paul: Yes sir.

Professor #3: …for example.

Paul: Um hmm.

Professor #3: So, I think that would have some impact.

Paul: Um hmm.

Professor #3: But, uh…and…we can just about guarantee you that you will get a job—you know, a teaching job—but, you know, at a community college…

Paul: Yes sir.

Professor #3: …or maybe a four-year college.

Paul: Right.

Professor #3: OK.

Paul: OK. Well, when—and these last couple of questions are more about understanding, like, physicists from the point of view of their own careers so that other physicists may be able to learn from that…

Professor #3: Yeah. Sure.

Paul: …but, when was it that you actually became interested in physics?

Professor #3: Oh, very early in life. I got a telescope, you know, very early in life—like in first grade—and started looking at the moon and Jupiter and things.

Paul: Yes sir. So, very early?

Professor #3: Very early, very early on. Yeah.

Paul: And, I've noticed that's similar in the biology [the interviewer meant *biographies*] of great physicists that…they start early, it seems…most.

Professor #3: Yeah. Yeah.

Paul: What were the important factors that allowed you to be successful in physics?

Professor #3: Well, one thing you have to realize is you have to study a little bit harder, you know, maybe than in some other fields. But, that if you do—and, maybe this could have been emphasized to me more when I was doing it—is: there really are a limited number of things that you have to learn. And, if you work ten, twenty percent harder, you can get about twice as good at them, with just a little bit of extra work.

Paul: Um hmm. OK. Well, what would you say to young students—a young student—who is interested in majoring in physics? What would you tell him would be the benefits or the drawbacks to that career?

Professor #3: OK. Well, the benefits are that you get paid to do your hobby.

Paul: Yes sir.

Professor #3: OK? That's the benefit. And, the drawbacks is…you know, there's some time constraints, you know, that you're going to run into. It can take a lot of time. And, you just gotta learn to…to maybe do things a little bit more efficiently…

Paul: Right.

Professor #3: …so that you can juggle multiple responsibilities…

Paul: Yes sir.

Professor #3: …not just physics.

Paul: OK. Well, I thank you for the interview time and…do you have anything else you would like to say about physics in general or physics in Mississippi?

Professor #3: Well, one thing we get to do is, for example, we're collaborating on this proton-proton collider experiment in Switzerland, right now. And, we've just found a brand new particle there. It's the second heaviest fundamental particle that's ever been discovered—about 140 times heavier than the proton. And, as we look at it a little bit more closely—now, we're almost positive that it's there—but, we have to find out some more of its characteristics to tell if it's the proverbial Higgs boson. But, it very well may be. It very well may be. And, so you get to be involved in stuff like this.

Paul: Yes sir. And, Mississippi…University of Mississippi physics was a part of that?

Professor #3: Yeah. Parts of that detector, that are over there at CERN, were actually made here in this building.

Paul: OK. That's very interesting.

Professor #3: Yeah. And, some of the design work was done here in this building, to build that detector. So, you get to be a part of stuff like that.

Paul: Yes sir. Well, I thank you for the interview.

Professor #3: OK. Well, thank you.

Interview with Professor #4, Physics Professor at the University of Mississippi (July 2012)

Paul: In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places?

Professor #4: Well, we get students from Mississippi, other states, and abroad, and I've had strong students from Mississippi…just as from other states. I think, in general, that the students are qualified to go to graduate school, and they make it into graduate school. They can be as strong as students from other places. So, just on the surface, I can't say that they're particularly, uh, significantly weaker than students from other states or abroad. One can argue that maybe in some more detail, but there's not so many students going through the physics system, and so it may be a hard thing to gauge. So, that's not an easy question to answer.

Paul: OK. Thank you. In general, how do American students compare with international students, in your opinion? If there is a difference, what are the reasons for these differences?

Professor #4: The international students…some can be very strong…and, as we admit international students, we have to be a little careful about the university they come from. So, they, in principle, have similar problems in training students, also. What we find is that most international students are more inclined to be more theoretically inclined, and so I can only guess that in some places they don't do as much laboratory work. I think one of the strengths, maybe, of U.S. students is that we integrate into our curriculum…even at the high school level…we advise that there be some level of laboratory work where students can get some hands-on experiences. And this is clearly true at the…even at the undergraduate level or at college or junior college level. We always encourage that students do lab classes with their physics courses. In fact, we require most of the…undergraduate requirements are that—even to go to grad school—we would require that the students take some laboratory work. When students come abroad, you really don't know what they've had in their background. Quite often, they're very strong on their standardized tests, but they can actually be…not know very much about laboratory situations. So, that's my comment about that.

Paul: OK. Thank you. Do economic factors play a large part in students choosing to pursue or not pursue graduate studies in physics? And, if the economic factors…if it is a factor…does this factor differ from country to country, in your opinion?

Professor #4: Yes…uh…just in the U.S. or, uh, we can talk about Mississippi—maybe that'll be a question that's coming—but, as I said, even students coming abroad, you have to be very careful about the universities they are coming from. And, some of those universities are very rural, and they could even be—they may not be well-prepared. It seems that high schools and colleges that are preparing students in rural areas are at somewhat of a disadvantage, and that maybe they don't have the same level of resources. And so, typically the stronger students will be from universities that are in the larger cities, I would say…abroad. Although, you know, I'm from a small town [in a state in the U.S.], and somehow I'm now a professor of physics, and so there's a way to succeed if you work very hard.

Paul: OK. Thank you. In your opinion, what could be done to make the Mississippi education system better for producing highly skilled science and math students?

Professor #4: This probably starts at the high school level where students are given training in math and science. The math courses have to have sufficient complexity—not just memorization—to give them college math skills. And quite often, I think we're seeing that this is a bottleneck. A lot of the students coming in…maybe…are weak in math. And that's not going to help them out in any of the sciences, whether it's biology, chemistry, or physics. So, a student weak in math will have trouble going into any of these sciences, professionally. And so, my advice would be that students should take as much math as they could in high school. The second part of the answer would be that if a student wants to become an engineer, then he probably needs to take physics in high school, and quite often, this won't happen. Maybe the high school doesn't offer physics, or it offers it every other year. And so, I think if a student is really interested in engineering, he's got to somehow be able to take physics in high school. Quite often, chemistry and biology are emphasized, and physics is the third of the sciences that is maybe the most difficult. But, I think we have to place a little more emphasis on having all high school students, maybe, try to take physics. Now, that leads us, of course, to the problem of training high school teachers to teach physics. And that's probably what this thesis interview is about, ultimately.

Paul: Exactly. Thank you. When did you actually become interested in physics, if I may ask? In other words, did you take physics in high school…or when was it that you got interested in it?

Professor #4: Right…so I, I grew up on a farm, and I always liked to watch my Dad work with the tractors and things. And, I guess I liked to work with my hands. And, I remember getting a chemistry set—maybe that's how a lot of scientists started—and setting it up on a little desk on the table (and probably doing some dangerous things). And then, luckily enough, in high school, we did have a physics course. And, I remember it was a bit more memorization than actually doing physics things, and maybe…I don't recall doing a lot of labs. But, at least I was happy that there was a course in physics offered, and I'm pretty sure that the chemistry teacher taught the physics course.

Paul: Yep.

Professor #4: But, anyway, I began to become very curious about things in physics, and I may have tried to understand things at the next level. I remember trying to do science fair projects, and I remember my dad helping me. And, when I went to college, I came close to being…I decided I was either going to be a geologist or a physicist. [*At this point, a brief pause occurred in the interview due to someone entering the room or maybe due to a cell phone buzzing or something of that nature.*] So, when I got to college, I applied to be a physics major. And it was very difficult, because there were students from other places that just seemed to know a lot more than I did, but somehow I persisted. And, eventually, I began working with somebody in the department in nuclear physics—he had a nuclear physics lab. And, I began working in his lab and doing things, and you know, I could excel at certain things. I liked lab work, and I think he realized that I was good at this. And so that's how it all got started. I eventually struggled a bit, but I got through my first-year courses and began to take more advanced courses. And, I guess it all blossomed—I worked very hard—and, then I got into graduate school, at some point, in physics.

Paul: OK. Since you've had a successful and a long career in physics, what would be your advice…the most important factors that allowed you to be successful in physics, if you could say?

Professor #4: Yeah, uh, these might be common attributes to a scientist. The first thing is curiosity…so there's blind curiosity about the world, always trying to discover new things. I think you have to also have a sense of not believing everything you're told. Your first reaction to dogma might be to think that, "Well, that might not be true in all cases, and maybe I should go and investigate." So, that would be a second trait. And, then the third trait has got to be just…just hard work. Sometimes I can't believe, you know, all the notebooks and homework problems and things you have to do to finish a class. I'm just astounded by…sometimes I look in my old notebooks and things, and I can't believe I even did all of this at some point. So, it's just curiosity, a sense of disbelief or wonderment about the world…and never taking anything as absolute fact, maybe…and then finally, the very hard work it takes to be a scientist. Those are the three most important things, I think.

Paul: OK. Well, whenever—this is sort of a tough question—but, whenever students are being advised, do you think, realistically, the way the job market is, that physics represents a profession which Mississippi students can realistically obtain a well-paying job with satisfying job conditions? In your experience over the years, what would be your opinion on that question?

Professor #4: Right. Part of the answer is that every state has a different profile of businesses in the state, and unfortunately, Mississippi doesn't have a lot of what I would call "applied physics businesses" that are doing applied physics. And, I say "applied physics" because a lot of our…a lot of students you train should have some capability going out into getting a job in some field where they're applying their skills at the bachelor's level. If you want to do graduate work, maybe, you…I guess if you're trying to get your PhD, you maybe can't think of…you know… you're going to be looking for a job, and it could take you anywhere. But, what I always think is that in every state there's…you know, if you're living in California, there's Silicon Valley…but, we just don't have something like that in every city in Mississippi—it's still a very rural state. So, uh, my hope is that when students come to get degrees in physics, that we train them, uh, we give them enough skills that they can go out and look for these applied physics jobs. Sometimes, engineering firms will hire physics students because physics students have a different way of solving and looking at problems. Engineers are trained in a very narrow approach. This inquisitiveness that physics students have often makes them approach a problem in a different way, and even sometimes give more creative solutions. So, I think most of the firms that I know about who hire scientists would probably hire a physicist or an engineer, equally, and so we just have to make sure our undergraduate physics students get good solid training in what I would call "applied physics areas".

Paul: OK. Well, we're almost finished with the interview, and I appreciate the time you've given, but I was wondering if you had any more comments or advice for any future Mississippi physics students that may come to Ole Miss or another college?

Professor #4: Right. So, I think, from reading some materials that Paul gave me earlier, that Mississippi has done a pretty good job of…uh…they've established the math and science school, and there's some really good high schools in the state. And, a lot of our physics students are coming from those areas around Jackson or around the southern part of the state. The students we also have to inspire are the students in the Delta at the more rural high schools in the state, and this is a harder job because the resources aren't there—and we just don't have a lot of physics teachers to spread around. There're, you know, there're probably…uh…you can count them on one hand, the number of really trained physics teachers in the state. This is probably not uncommon. I think other rural states have a similar problem, but we have to make some effort to inspire these students and to try to bring them in to the university. I think everybody has a good mind, and if you're curious and you like math, you're curious and you want to work hard, you can become a physicist or an engineer or a scientist. And, there is no reason that anybody can't do this.

Paul: OK. Well, I thank you, and that's the end of our interview. And, I really thank you.

Professor #4: Thank you, Paul.

Interview with Professor #5, Physics Professor at the University of Mississippi (Summer 2012)

Paul: In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places? Or, do you have any basis to answer that…or just…what is your opinion on that general question?

Professor #5: Well…not having taught the undergraduates in Mississippi, it's harder to tell. But, I judge that more by who we're admitting; and either they're not coming here, or they're not as well-prepared, one of the two.

Paul: OK. In general, how do American students compare with international students, as far as you can tell?

Professor #5: Well, the international students tend to start concentrating earlier in specializing in physics or something. So, if they're going for physics, they start with math and stuff. And, for them, by the time they get into undergraduate, if not earlier, they're already tracked to do just physics. So, they're not taking courses in general education and the like because they assume that, like it used to be in this country, in high school you got enough of a general education.

Paul: OK…OK. As far as you know—and some of these questions are hard to answer, but—as far as you know, do economics play a factor in students choosing to pursue graduate studies in physics? And, if these economic factors do play a role, does it differ greatly from country to country, as far as you know?

Professor #5: Well, as far as country to country, they have to have enough money to get here. We'll start with that. But, once they've got enough money to get here, most of the graduate programs in physics, in the United States, offer support to the students, either in teaching assistantships or research assistantships—usually starting as teaching, and then later as research. So, it is possible to work your way through at least graduate school with an assistantship. Now, undergraduate…uh…maybe there aren't as many assistantships.

Paul: OK.

Paul: What could be done, in your opinion, to make the Mississippi education system better for producing highly skilled math and science students?

Professor #5: Well, again, I'm less familiar with the details of the Mississippi education system. Perhaps putting a little more emphasis on…well, math, science, and other…even just other scholarly things, and less on this overweening emphasis on sports.

Paul: Yep.

Professor #5: I mean, the sheer amount of time spent by the students on sports compared to what they're spending in class—if you count, you know, going to games or whatever—and, the amount of effort that a teacher has to put into handling that. I know of one of the local high school teachers who seems to spend all their time—or a lot of their time—dealing with sports, and they don't have the free time otherwise, because they're always having to chaperone the students…if they're on the road, or whatever.

Paul: OK. There's a few questions here that are more…I guess, asking about…to learn facts about your own career, a little, to possibly help future Mississippians or future Americans or any people, so that they can learn to be better physicists. But, when did you actually become interested in physics?

Professor #5: Well, as we actually discussed earlier, I would have called it…if you called it "science in general," from a little kid…well, back before I even got into any public school, you know…kindergarten and that era, at some level. As far as calling it "physics," that would have been high school, because prior to that, they didn't have separate courses in physics.

Paul: OK.

Professor #5: You got the physics in a general science, but you wouldn't have called it physics. And, yes, I did take physics in high school.

Paul: Yeah. OK. Well, I was wondering, like…did you really decide in high school that really, probably physics was what you wanted to do as a career or were you more, you know, more like many students (or probably most students) who decide in college that this is what I want to do?

Professor #5: Well, when I first went into undergraduate, I was debating between physics and chemistry. And, for me, I just felt physics was a little more "cutting edge," shall we say, in the research.

Paul: Yep.

Professor #5: And, that was just my choice and my opinion of the two.

Paul: OK. What would you say are the important factors that allowed you to be successful in physics?

Professor #5: Well, one is "sticking to it."

Paul: Yep.

Professor #5: In other words, just continuing to do the work and being willing to put the long hours, as needed. Plus, you know, having a good background, starting from my elementary school onward; I was lucky, they were pretty good. And, the colleges were good, as well.

Paul: OK. If you were advising a young student or someone who was interested in the physics profession, does…does…would you tell them…how would you answer this question? Does the physics profession represent a profession in which Mississippi students can realistically obtain a well-paying job with satisfying job conditions? Or…I guess that's…or any other aspect, is it a good profession? I mean, how would you…what would you say to a student who was kind of ambivalent?

Professor #5: Well, if nothing else, the training will do you well, no matter what other profession. I'm assuming we're talking about in science in general…

Paul: Yeah.

Professor #5: …though it certainly wouldn't hurt for journalists and others to know something about science, including physics.

Paul: Yeah.

Professor #5: But...yeah, it's…you know, it's not that wide of a field, you know, there aren't hundreds and thousands of jobs in physics—certainly not in Mississippi. But, yes, you can get a good, well-paying job; or, you can apply what you learned in physics to a job in medicine, or chemistry, or biology, or engineering, or whatever.

Paul: OK. Well, I thank you for this interview and the advice you've given, and…and that…do you have anything else that you would like to say about physics or physics in Mississippi?

Professor #5: Not off hand.

Paul: OK.

Professor #5: Thank you.

Paul: Well, thank you.

Interview with Professor #6, Physics Professor at the University of Mississippi (Summer 2012)

Paul: In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places?

Professor #6: No.

Paul: OK.

Professor #6: I can elaborate. Do you want…

Paul: Well, in what ways, as far as you can tell from your experience?

Professor #6: What I've noticed, since I've been here, is that our own students seem to be less well-equipped to compete in the class work with the students that we get from other places. Most of the students that we're getting from other places are foreign students. We are getting more domestic students. But, what we've found regionally—there are a few exceptions—but, from some of the smaller state universities, regionally, they haven't been as competitive with the foreign students.

Paul: Yes sir. OK, well, this question is similar, and it may be hard to differentiate, but how do American students compare with international students, in your experience? And, if there is a difference, what may be the reason for these differences?

Professor #6: I think it's their level of preparation. I think most of them come from places that have a stricter curriculum…

Paul: Yes sir.

Professor #6: …that are…you know, it's obviously more demanding. One place that we see that is in GRE scores.

Paul: Um hmm.

Professor #6: There is a subject test in the GRE specifically for physics. And, typically, American students do not perform as well as foreign students on this. Now, there could be any number of reasons for that other than just pure ability in physics.

Paul: Yes sir.

Professor #6: But, I think the better preparation they may have—they're in schools that are probably much more focused on teaching than they are on research.

Paul: Yes sir.

Professor #6: And, you know, if you're not good, you don't get out of a foreign country to come to America.

Paul: Right.

Professor #6: And that's another issue, as well, is: you know, if we're getting Chinese students—there's a huge population of Chinese students—and we get very good ones that make it out of China to other places.

Paul: OK. Well, what could be done to make the Mississippi education system better for producing highly skilled science and math students, if anything can be done?

Professor #6: It's really hard for me to judge that. I'm not a native here. I didn't go to high school here. My children are not yet of high school age, so I haven't really seen…although the Oxford schools seem to be very good, very strong, and they produce national merit scholars and other things. I have been pleasantly surprised by some undergraduates that I've had from small places around Mississippi who're very strong and do very well. So, it's not always students from the places that are more affluent, where you might expect to have the better schools, that perform the best. I had a young kid from—a public educated kid—from some small town, who's a biochemistry major who just, you know, flourished in my introductory physics class. So, there are examples of that sprinkled all over the place.

Paul: OK. Well, the latter few questions are mainly dealing with things that may help find commonalities about why people choose physics or why professors choose physics. But…when did you become interested in physics?

Professor #6: When I took my first physics course my sophomore year of college. I had had physics in high school; I enjoyed it, but I didn't find it particularly stimulating. At that point, it was mostly, you know, vector diagrams and other things. In college, I kind of bounced around my freshman year before I kind of landed my second semester in a mathematics program. And for that, I had to take a physics course, the science and engineering physics, and it just really clicked with me at that point. And, it wasn't long after that, that I decided to become a physics major. Really by the next semester, I had become a joint major in physics and math, and started to read popular books on physics…and just fired my imagination, and I was hooked.

Paul: OK. Well, what would you say are the important factors that allowed you to be successful in physics?

Professor #6: Really, I think for me, it was just having a passion about the subject matter. I think people who go into physics, they're not doing it to be trained for a profession, generally. Most of them just really enjoy physics. And, so, I think my motivation was just I really found it fascinating. I was always a good student, so I always strived to do well in whatever courses I took. But, with physics, you know, that's where I wanted to be; and every little layer that would be uncovered to me, uh, I wanted to know more.

Paul: Um hmm. OK. Well, what would you say to a young person who was considering a profession in physics, as far as, what would you say are the advantages and disadvantages of the profession of physics?

Professor #6: I think from an undergraduate degree in physics, there are a lot of options for different types of programs, professional programs. Of course, here at Ole Miss, we have a very strong pipeline into the medical school, um…and, you know, all kinds of different professional schools, particularly in the health sciences. The teaching, um…teaching at the high school or community college level or even at a four-year institution. But, for the most part, like I was saying before, you don't go into physics because you're looking for a specific job. I think the one thing that I would advise someone: "Do you have a passion for the subject matter?" OK? "Is it something that you just feel like you've got to slog through? Or is it something—even if you find the material difficult—is it…do you have a desire to peel back the layers of the onion?" Um, you know, that…to me, uh…physics is more…and…and most kind of academic subjects, I think, uh, the people who go all the way to Master's or PhD's are people who really have a passion for the subject and are driven more, in that, by their intellectual interest than they are by employment opportunities.

Paul: OK. Well, I thank you for the interview, and—unless if you have anything further—that…ends the interview.

Professor #6: Uh, no. That's great.

Interview with Professor #7, Physics Professor at the University of Mississippi (July 2012)

Paul: In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places…in your opinion?

Professor #7: I don't think they are. In terms of graduate students, the students who come from Mississippi universities aren't as prepared as those…and I think that tends to be the reason why we end up getting students—outsourcing—students from outside the country and even students from different states.

Paul: OK. In general, how do American students compare with international students, in your opinion? So, basically, my first question was concerning Mississippi students—and it may be hard to differentiate.

Professor #7: Yeah. In my opinion, there are two key differences. I think that foreign students tend to be better prepared in terms of academics. I tend to think that the foreign students come here already with a physics master's background so that they tend to bend the curve significantly. And so, you have American students who don't have any graduate level background to begin with in an introductory course. And so, the teacher tends to teach an introductory course at a more advanced level. And so, American students are competing with better prepared students. And I, I have a kind of a problem with that arrangement—those students should not be allowed in the same room with these students. Now there are completely new grad students from other countries—and that happens—but more often than not, you end up with students who have a much deeper background, because they're already walking in with a foreign master's degree. The key advantage that the American students have, compared to the international students, is that they speak the language. And, for teaching assistance purposes, the American students tend to do much, much better than the foreign students.

Paul: OK. In your opinion—and this is a sort of complicated question—but, do economic factors play a large part in students choosing to pursue (or not pursue) graduate studies in physics? What is your opinion on that?

Professor #7: They don't tend to advertise it all that well, but I think the physics graduate assistantship is among the best on campus. I think it's much—I mean, leagues—better than English or engineering, and not many people realize that. That's a serious plus, that I consider, for this department is that: a graduate student in physics can live on their own in Oxford, Mississippi, and live comfortably. And so, that is not a problem.

Paul: OK. What could be done to make the Mississippi education system better for producing highly skilled science and math students, in your opinion?

Professor #7: Getting highly skilled math and science teachers…which is a problem, because…you're going to have to do it from the base up. The high school teachers tend to be…tend to come from football coaches, cheerleading coaches, and they say, "Oh, by the way, you're also going to teach chemistry and physics." And, they're completely just…they're not professional physics teachers, they're not professional math teachers. And, you do have some, but those who are truly qualified end up teaching at a junior college level or a collegiate level. And, you really need to get a broad pool of talent at a lower level to even begin. It may end up having to be that there aren't just enough people, and so you have to deal now with…there may have to become or there may have to rise up some type of distance learning program or self-paced learning, where you get an individual who does understand physics, but he can't go everywhere. So, the students have to go online to him, because there just…obviously, there's just not enough qualified teachers.

Paul: OK. When did you actually become interested in physics, and what were the things that made you choose [physics]?

Professor #7: I became interested in physics probably like…sophomore…freshman in high school…really enjoyed working with the computers at the time, and…science came at an early age, and physics came in at about early high school. And, I had a really good, really good chemistry/physics teacher.

Paul: In college or high school?

Professor #7: No, in high school.

Paul: OK.

Professor #7: At first, I thought he was quite average, but the more that I look at my students and their high school chemistry teachers and physics teachers, I realize mine was actually quite good.

Paul: Is that when you actually…was it in high school that you actually said, "This is what I would like to do."?

Professor #7: I thought that I wanted to pursue physics. Teaching physics didn't rise up until much later, until after I really graduated.

Paul: OK. Well, seeing that you've made it so far in physics—because to be a physics professor, you have to have spent many years in the subject and done many things—but what would you say are the important factors that allowed you to be successful in physics?

Professor #7: This is a question that actually one of my fraternity—I had to do an interview like this for the son of one of my fraternity brothers, and he asked the same question. And, I said two things. One: confidence, bordering on the level of arrogance.

Because, to be in physics, you have to be very confident in what you do, and you can't show a room of a hundred students that you're teaching any form of weakness. And, when I speak in a classroom—me speaking in a classroom is just like me talking to you. I feel comfortable, and I rarely…I rarely, if ever…it's more of a…it's kind of interesting to feel like any minor form of performance anxiety, of like…just like, "Ooh, I'm feeling stage fright…ooh, that's kind of interesting…I've never felt that in like three or six months."

Paul: Yep.

Professor #7: And so…and also in physics, it's like everybody tends to be arrogant or highly confident. And so, your physics ideas have to stand—and particularly in the research field—they have to stand their…those ideas have to stand their ground. And, you have to be prepared for people to attack you, because your ideas may be in conflict with others. And so, you have to be able to defend it. There's so many times where I get students…I ask them a question, and they go, "the answer is three?" And, you can tell that they're…they're guessing, and they just want you to confirm…they're…they're farming for the answer…and, I tell them, "Look, I'm not going to play that." And I go, "What's two plus four?" And, I turn to them, and I go, "The answer is elephant."

Paul: [laughing softly]

Professor #7: And, it's just that confidence…it's like, "Look, I don't care if it's right or wrong, you say it with confidence! That's the more important part."

Paul: OK.

Professor #7: And, I told my fraternity brother's son that the second thing is just a tinge of…or just a small portion of insanity. That physics…you have to know…you have to embrace new ideas…you have to consider just these weird—who can understand a magnetic field? You can't see it, but you have to envision it. And, you have to manipulate things in it. And, a lot of people would consider that an insane thing.

Paul: Yeah. [laughing]

Professor #7: And, neither of which is actually knowing your material, but I think the arrogance and the insanity part are, I think, very important parts to being a good physicist…

Paul: OK.

Professor #7: ...and good physics.

Paul: Well, what would you say…let's say if there was some student who was wanting to major in physics, you know, in Mississippi? What would you say? Would that be a good job choice for them? Or, what would be your advice? Is there a realistic job choice for a young student or is it…what would just be your advice on that—someone who was wanting to pursue physics as a profession?

Professor #7: Hmm. It's always good to understand physics because to understand physics is to understand thinking. From what I understand, if you're a physicist…there were six applicants that went to med school, and all six got into med school in Jackson. So, to be a physicist—a lot of people don't understand it, I do—you're hardcore when it comes to your academic abilities. In terms of…I could live here professionally as a tutor. Any academic town…you could put your shingle up and say, "I am a professional physics tutor, slash math tutor, slash algebra tutor," and swarms of people would come, because…there is a distinct vacuum of qualified people teaching. It's OK not to be a professor here, you could just tutor. And, I've been offered tutoring gigs in, like, engineering, accounting, algebra, calculus, all that stuff. And, so much so that I've had to raise rates and turn them away. If you really knew how to teach and teach well and got a good reputation, you couldn't starve in this town. I'd walk over to Hume Hall and just put out a little sign that says, "I'm a tutor!"

Paul: [laughing softly]

Professor #7: Because, those grad students over there, from what I understand, are mostly foreign. And, to be…that key advantage for an American student—communication. That's…that's a distinct advantage over many of the foreign students.

Paul: Ok. Well, do you have anything else that you might like to say about Mississippians in physics or physics in general?

Professor #7: Physics is hard. The problem with physics is that we get a lot of…like…you toss in a language barrier with a teacher, and they're unable to communicate, and then it…it makes it even harder. And so, you've got to have…partially the student has to be willing to learn, and the teacher has to be willing to teach; and they have to be willing to communicate with each other. I don't speak Chinese, so I don't teach in China. And, I'm not saying that…if I knew Chinese, then I'd be able to teach in China. And so, I think the first key thing for a lot of teachers in Mississippi is that they have to be able to communicate in the language of the student. And, that is the big…that is the big tough thing to do, because I don't think that there are that many people who can do that; and I think that's a realistic…or, that's just a truth. It's impossible. And I think that for some real change to happen in the state of Mississippi, we're not talking about something that would happen overnight. It would take a lifetime. You're talking about a fifty year program…

Paul: Right.

Professor #7: …where you would have to start shifting out all of the teachers that we do have who are just crud, and then just start switching them in…and…it would be a generation—like a Manhattan Project.

Paul: Right.

Professor #7: And, that's not what government is…government, in terms of the politics…to want to change it overnight…and that's an impossibility. Umm…I do think that with technology and stuff, that you can improve on things. My, always, vision was—now, you may have seen it—is…I'm coming up with the idea of the…in the Star Trek series Voyager, the emergency medical hologram…you could have the emergency physics hologram, where you could get…if you could find, like, the best physics teacher and make him a hologram, and he would be hooked up to a computer. And, that would be the perfect teaching environment, one-on-one. And, so you would never have teaching environments where it was, like, fifty students to one teacher. It would always be one-on-one. And, there's…I believe that we're approaching that. I don't know when it's going to happen, but with the IPad and stuff like that—or, the textbooks are going online and becoming more interactive—that, umm, the ability to teach students in Clarksdale, and Hattiesburg, and places where obviously the best teachers aren't going to be attracted to such remote locations…that I think it's… I'm definitely upbeat about it. I'm positive. But, it's still…it is definitely a non-trivial problem.

Paul: Right.

Professor #7: And, it will require a lot of time and a lot of effort.

Paul: OK. Well, I thank you…

Professor #7: Um hmm.

Paul: …for your advice and instruction and…

Professor #7: OK. Did I help? [laughing]

Paul: You did!

Professor #7: [laughing]

Paul: And, I will---unless if you have anything else—I will stop the interview, and I…

Professor #7: OK!

Paul: OK. Thank you.

Interview with Professor #8, Physics Professor at the University of Mississippi (Summer 2012)

Paul: In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places? That may be a bad question, but…as far as you can tell?

Professor #8: I mean, I feel like…you know, this is kind of a hard question. For sure at Ole Miss, definitely what I notice is: there's a really wide range, first of all. Right? You're going to find that some students from Mississippi are going to be quite well-prepared, and really do extremely well. But, I would say, overall, I think there is definitely a lack of preparation; and most of it is what I call "foundational knowledge." Not even about physics. Right? It's basically…OK…like, their math preparation might not be as good. And, just…I mean, critical thinking skills, I think, might not be as good. And, I generally think that's just because—and I don't know this to be true—but I suspect it's simply because whoever teaches in the high schools probably have the same problems, and it's not even the fault of the students, I often say. It's just…they go to school, and they do the best they can with what they get, and that's—I would say, yeah, generally, I think their preparation is not as good.

Paul: Yeah.

Professor #8: That's what I would say.

Paul: OK. In general, how do American students compare with international students, in your opinion? And, this may be a similar question, but….

Professor #8: I think it's…it's…I think, generally, international students probably are better prepared, but it's not a fair comparison when you think about it. Right? Because, who are the international students that come here? The ones that are the best students…

Paul: That's true.

Professor #8: …in whatever country they come from. Right?

Paul: Um hmm.

Professor #8: And so, that's like a natural filter, I think. So, let's say you have students who come from China or India or whatever. Right?

Paul: Um hmm.

Professor #8: To go to American universities is not cheap. Right?

Paul: Right.

Professor #8: So the ones who come here tend to be the ones who are the better students, generally speaking. And so, you don't get like the full sample of students from an international country that you get…as you get the full sample of students from United States, because students from the Unites States are going to come from everywhere. You get the full range. But with international students, there's a sort of natural filter where you get the best students. So, it's really not a fair comparison. My guess is: if you compare the full range, you're not going to get that big of a difference.

Paul: Right.

Professor #8: But, what you get is just these few…

Paul: That's a good point.

Professor #8: …and all these people are still back there.

Paul: That's a good point.

Professor #8: So, that's why I think the comparison is not fair. But, if what you take is just what you have, it looks like they're better prepared.

Paul: Right. OK.

Professor #8: But, it's not a fair comparison.

Paul: Yep. OK. Well, another thing that I've…I've…another question concerns, like, economic factors. Do economic factors play a large part in students choosing to pursue or not pursue graduate studies in physics?

Professor #8: I mean, I don't really know. I suspect that the main hurdle is the difficulty…of the subject matter. That's what I think.

Paul: OK.

Professor #8: So, basically…OK, this is how I look at it, OK. This is my opinion.

Paul: Right.

Professor #8: So, for [getting a] PhD in physics, you've got to jump this high [*Professor #8 motions with hand*], and then what you earn is this much money. So, if I get a PhD or even, let's say, a master's—an MBA or something—you have to jump like this high, and then you earn this much money. [*Professor #8 used hand motions to illustrate the various heights to which the students must jump, in this figurative analogy*.]

Paul: Right.

Professor #8: So, most people are going to jump this high, and take this much money. [laughing]

Paul: That's true. [laughing]

Professor #8: That's just what I think. [laughing]

Paul: That's true. [laughing]

Professor #8: So, I think it's more of the difficulty of the subject matter, and to some degree it is economic factors. But, I really think the difficulty of the subject is probably the biggest reason. That's what I think.

Paul: Yeah. OK. Well, one thing about the economic factors: I'm curious if these may differ from country to country. And, I don't know, but I guess what I mean is: do exchange rates play a role in making physics more…I guess…more doable for someone? Let's say, for instance—this is just my own thought, and it may be wrong—but let's say that someone came from a country with an exchange rate where, maybe like the Euro and the Dollar was here, so 20,000 dollars to that person would be almost unlivable if they tried to somehow carry that back. I mean, it may make it less likely for someone from a country like that to come [for] graduate studies. Whereas, let's say someone came from a country where 20,000 dollars in their country was worth 40,000—the equivalent of 40,000 dollars on the exchange rate—and maybe, possibly, it would make it more possible…if they could save a little bit…somehow save a little. Would it…would it be possible? Is that true? Like, that there's a difference in exchange rates?

Professor #8: I mean, there is a difference in exchange rates, but what I think is, you know, at the end of the day, what matters is: you know, what's the cost of living where you live? Right?

Paul: Right.

Professor #8: So, let's say…I…I do think that the difference in what you earn between—not just physics, but really almost any science subject—and things like business, and finance, and even engineering…the gap is much bigger in this country than in most other countries.

Paul: Right.

Professor #8: So, a physicist might earn decent sums of money—not going to earn money like the, you know, CEO of a bank or anything—but the gap between let's say just some guy who works in the bank…

Paul: Right.

Professor #8: …and he's earning nice money…yeah, he might be earning more, but it's not going to be like this big [*motions with hands*]. In the U.S., it will be this big; in most other countries, it will be smaller.

Paul: Right.

Professor #8: So, I would think that because you don't have such a big gap in earnings—at least not as large—then, economic factors would matter less…in that case. I think it matters more here [in the USA]; just because it's just so much easier to earn a lot more money doing something else.

Paul: Yeah. Well, what could be done—if anything—to make [the] Mississippi education system better for producing highly skilled science and math students?

Professor #8: I mean, in a way it's not hard, because we know what to do; and in a way, it's hard, because nobody's going to do it. This is the problem. I mean, I just think…I really believe that it's just…it's purely a question of getting well-qualified teachers to teach in these schools. However, I do believe that there are major problems impeding kids learning at school such as poverty; many come to school hungry and don't have a good educational environment. But, all other things being equal, I think it's purely a question of getting well-qualified teachers to teach in these schools.

Paul: Um hmm.

Professor #8: And, to get well-qualified teachers to teach in these schools, that means you've got to pay them some money.

Paul: Right.

Professor #8: Not whatever they pay them now, which is not a lot.

Paul: Right.

Professor #8: And, so nobody's going to suddenly double the salaries of teachers. That's not going to happen.

Paul: Right.

Professor #8: And, then I think, also, you have to spend some money on…you know, laboratories, and things like that. And, I don't mean just computers, right? It seems to me every time people talk about spending money to improve schools, what they mean is: buy a bunch of computers. That doesn't do anything.

Paul: Yeah. [laughing]

Professor #8: I mean, you know, kids have computers at home all the time.

Paul: Yeah.

Professor #8: So, I think it's purely a matter of…you know…if you get well-qualified teachers in the high schools, I think you can solve this problem very quickly. I mean, it might be generational; it might take like…you know…you have to like get a generation of students out. But, I mean, I don't think it's the students.

Paul: Yeah.

Professor #8: Clearly, right? It's just a matter of who's teaching them.

Paul: Right.

Professor #8: And, at the same time, I don't want to say the teachers are so bad. Right?

Paul: Right.

Professor #8: It's just…you know, I've had sort of…just, you know, talking to my students, you know, I've heard from several that…one guy told me the guy who was teaching his physics class was a basketball coach.

Paul: Um hmm.

Professor #8: So, it's not that the physics teacher was bad, it's…[word obscured on recording]…he wasn't one, right?

Paul: Yeah…that's true.

Professor #8: So…that's the problem.

Paul: Yeah. Or, maybe they had to teach other subjects…like, many other subjects…

Professor #8: Yeah.

Paul: …rather than focusing on physics.

Professor #8: Yeah, and I think if the pay was better, then people…I mean, I think there's people who actually like teaching and probably would like to do it. But it's just like, "How am I going to live on this money?" Right?

Paul: Yeah.

Professor #8: So, they just…they just don't. And, I think that's the problem.

Paul: Yeah. Well, what was it that made you interested in physics? Like, what were the factors that got you interested in physics?

Professor #8: It just seemed like the only real subject. I mean, I don't know how else to put it. Like, everything else seemed extremely contrived. Right? I mean, like, if it's chemistry, you're just mixing stuff up, and…OK, it's kind of fun to blow up sodium and water, but…OK.

Paul: Yeah.

Professor #8: And then, biology is—it's just messy, you know. But physics is—it's like all organized, you know. And then, at the same time, it's like, there's all this math. Right? Which can seem kind of a problem, but at the same time, it…you know…it ends up telling you something. Right? So, for example, if you look at Newton and gravity and electrostatics, and you look at the force equation for both: it's exactly the same equation. Right?

Paul: Yeah.

Professor #8: So, I mean, these are the sorts of things that I found interesting, that you can…specifics you can reduce, you know, a lot of phenomena to like…you know, you can basically reduce a lot to a little bit. And sort of go from that. But, with…like with biology, you just have to learn all this stuff. Right?

Paul: Yeah.

Professor #8: Which, I'm not good at learning tons of stuff. And, with chemistry, it's like, "Oh, I mix this thing with that thing, and I get this thing."

Paul: [laughing]

Professor #8: It just didn't make sense to me.

Paul: Yeah.

Professor #8: So, physics was really the only thing that made sense, I guess….is one way to put it.

Paul: Yeah. Well, what would you say are the important factors that allowed you to be successful in physics?

Professor #8: I mean, I just think—now that I teach [a basic-level physics class]—I really feel like one thing that was really important was: I had a pretty strong math background. So, in other words, instead of having to spend a bunch of time figuring out the mathematics to be able to study physics, "Well, OK, I knew that already." And so, all I had to concentrate on was the physics. Because…my impression of my students is: a lot of times the problems they have, it's not so much the understanding of physics concepts. Right? They just have a lot of problems dealing with the mathematics. So, they spend a bunch of time manipulating equations, and trying to do this, and trying to do that. And, they get lost in the forest, and they can't even see the trees, which is the physics. And, I think that's the problem. They have to spend too much time on stuff that really—I don't want to say they should know—but, if they knew it, it would make life much, much easier.

Paul: Right.

Professor #8: So, I mean, I think that's really what helped me a lot, because I could spend time studying physics and not trying to figure out a bunch of mathematics.

Paul: Yeah. Well, what would you say to someone who was thinking of considering physics for a profession? What would you say are the advantages and the disadvantages, as far as physics as a profession?

Professor #8: That's a very good question [laughing]. Well, the disadvantages are easy [laughing softly].

Paul: [laughing softly]

Professor #8: Aw man…well, it's hard. Right? So, that's one disadvantage. And, I just think it's something you have to really, really love. Otherwise, you just shouldn't do it; because it's just not worth it, otherwise.

Paul: Right.

Professor #8: I mean, if you love doing it, and you have something interesting that…you know, if you love doing it, and it's very interesting, so that's an advantage. Right? You sort of are free to study different things that you find interesting, so that's an advantage. But, it is very difficult. That's definitely a disadvantage. You know, it can take a lot of time. That's a disadvantage. It's not like you're going to earn a ton of money here, OK.

Paul: Right.

Professor #8: I mean, if you get a job at a university, you get a nice, decent salary. It's not a bad salary at all. It's just, you know, you've got to do a lot of work for not a ton of money. [laughing]

Paul: Right.

Professor #8: So, it just depends on what's important to you. If what's important is to do something that you find interesting and be able to live a nice life…OK, I think that's—and you're ready to do some work—I think, yeah, those are the advantages. But, if what you want is to live a nice, fancy life and have a lot of free time…well, physics is not going to be for you.

Paul: OK.

Professor #8: So, that's pretty much it.

Paul: OK. Well, I thank you for helping me conduct this interview, and I guess—unless if you have anything further to say—that's all that I have today.

Professor #8: That's pretty much it.

Paul: Thank you.

Interview with Professor #9, Physics Professor at the University of Mississippi (Summer 2012)

Paul: In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places? Or, can you tell really?

Professor #9: Yeah. I mean, um…we have students from other places who appear to be better prepared than the Mississippi students. We have had some very good undergraduates coming from Mississippi, and they did our undergraduate program [inaudible words]…continued here. But for graduate students, I think, the standard has been not as good as we would like it to be.

Paul: OK. Well, in general, how do American students compare with international students, in your opinion? And, this may be a similar question.

Professor #9: Yeah.

Paul: But how do the Americans and the internationals compare, and if there are differences, what may be the reason, if there are differences?

Professor #9: I mean…the American students in our institution or in general? I mean…

Paul: That's a good question. I guess, first, in our institution…like…from your experience.

Professor #9: Right. Yeah. Well, I mean, there are obviously a lot of good American students; not all of them come to Mississippi. Now, the students that come to Mississippi, probably the international students—some are better prepared in their background. They have taken more science in their undergraduates. In their high school, they have taken more math. And so, overall, I think, generally the international students perform better.

Paul: Yes sir.

Professor #9: But, again, there are exceptions that have been very excellent. We have had many excellent American students who have done very well.

Paul: Yes sir. Well, I was wondering, like…see, I've never travelled much overseas. I've been maybe on a trip or two, just to visit, but as far as the education system…like…is it…is it mainly that we get…in your opinion, do we get the cream, you know, the top of the top from foreign places, and mainly, the education system, is it the same? Or, do they actually have a better system for training, you know, math and science students, in your opinion?

Professor #9: Right. Yeah, that's a good question. So, first thing we have to realize that the students who come here are the best that are coming from the…because, you have to be really good to get a scholarship, and most international students cannot come here without a TA [Teaching Assistantship] or something. So, you get the best students. So, we are really comparing American students with the best students that are coming from the outside…the other countries. So, yeah, that has to be taken into account. I think, uh, I feel that the other thing…there are a lot of good American students who…for international students, it doesn't matter if that person…so, for the international student, what is important is they look at the department, OK. They're doing good physics, and do they have good people? They're able to come? It doesn't matter whether it's in Mississippi or some other part of the country. For U.S. student, it's also important where they're going to spend the next five years of their life. So, some of them that…who probably don't see themselves living for five years in Mississippi…

Paul: Yeah.

Professor #9: …so they might go to some other place. So, there are other factors that come into their decision. Generally, I think, as far as the training is concerned, my experience—and, I grew up in a different country—is that there is more emphasis on definitely math in high school. Because, [some close acquaintances of mine] go to school here [at a school in Mississippi], and I always feel that there is not enough math or science that's being taught. So, we actually spend time at home, too…most of the kids of, you know, college professors/university professors do that. They do some extra work on school. So, I think…I think the main thing is I find the education in math, specially…because, the language of science is mathematics, so once you have a good grasp of that, it becomes very easy to … you have to know the language, you know.

Paul: Right.

Professor #9: If you are studying any subject, uh…if you are studying Shakespeare, and let's say you don't know English, then…[laughing]…you cannot do it.

Paul: [laughing]

Professor #9: So, our language is math. You know, if you are very confident in math then the concepts and things, you know, you can express. Because we have to…you know, science is a very precise subject, so…and math is a very precise language. So, you should be able to express, you know, in a very clear way. And so, it's very important to have a good background in math.

Paul: Um hmm.

Professor #9: So, I think that…[in] my experience…I have experience of students growing up in [*two foreign countries were listed by the professor*], and they are definitely doing a lot more math than our students here are doing.

Paul: OK. Well, this is a little different question, but I was wondering about economic factors. In your opinion, do they play a role in which choice…like…in why students maybe choose or don't choose to pursue graduate studies in physics?

Professor #9: Absolutely. Yeah. Yeah, I mean…economics plays a big role, I mean, even among high school students, you see that high schools which are in some places where, you know, people are well-off—they tend to be better high schools than….

Paul: Um hmm.

Professor #9: We see this in Mississippi a lot. So, yeah, I mean, the point is, everything has to start at…you have to start at the beginning, and I think everything starts from the first, you know. It's your parents, then your school. And, we see that, you know, for people who are—so, the problem we have is that when we have students coming in, they come with not that great a background. And, you can see a difference. The people who come up from better families tend to have better backgrounds; they have been able to go to better schools. And, others have…do not have a background, not because they're not good enough, but they just didn't get exposed to the training that they should have been, so….

Paul: Yes sir. And, I've noticed—I guess you've noticed this, also—that the children of, let's say, professors are going to be very much advantaged in the future, and maybe for generations…

Professor #9: Right. Exactly. Yeah.

Paul: …because the small tricks of math and things that maybe took the first one, you know, many years of trouble to learn…

Professor #9: Yeah, I think that the most important…uh, one of the things which is very important which everyone should realize is that, you know, you should have an atmosphere at home. So, if you want your kids to study and don't watch TV, you should not also watch TV. You cannot say, "Go do your homework, and let me watch some TV." So, uh, my father, who is a retired professor—so, we had the environment at home—you know, he came home and he was working. My mother was, you know, paying attention to education. So, that is…that environment is very important. So, that's why, I think, the kids of college faculty are in the university, because they have an atmosphere at home; and it really helps.

Paul: That's true. Well, in your opinion, what could be done—if anything can be done—what could be done to make the Mississippi education system better for producing highly skilled math and science students?

Professor #9: Yeah, I think you should again start at the beginning, I mean, start at the basics. So, I mean, you cannot wait for the kids to come to college to, you know, to work on their math and science. And, it should start from school, and before that, it should start from their home. You know, the first thing that I see missing is that, as I said, that there…you know, it's not enough just to send your kids to school. You have to follow up at home. You know, you have to have an atmosphere. You cannot have…you know…on a weekday having a party outside and kids running around. I mean, you have to go sit home, and you have to make those rules, you know, "You have to go and study, because you're expected to do that." So, that's the first thing. So, it's…you know…there has to, from first, from parent's side, there has to be an interest in education. Right? Even though the parent or the parents may not be well-educated, there should be an interest in education. That's very important for the kid. And then, you know, we have to improve the level of teaching in school. Right? I mean, I think our kids are smart enough. If you just give them the opportunity, give them the exposure, they will learn things. In my experience, I have…if…if…uh, I had a student who came and his math background was poor—in college—but he was willing to learn; so he used to come to me everyday. And he learned it!

Paul: Um hmm.

Professor #9: Because, he didn't know, not because he was not capable of learning it, [but] because he never learned it! No one taught it! Right? And so…so, if you start with an interest in your family for education, then the schools have to teach more, and then the kids will learn more. You have to realize that, you know, the world is very different today, you know. When our kids are going to grow up, they're going to compete with people from India and China—and they're working very hard, so… [inaudible words]. [laughing]

Paul: Right. [laughing]

Professor #9: So, life is going to be a lot more challenging for [them], so they better get to work—I mean, we still have a great educational system here, but…

Paul: Yes sir.

Professor #9: …but, you know, we really have to work hard. I mean, there is no…[laughing softly]

Paul: No easy way out! [laughing]

Professor #9: …no easy way out. [laughing softly]

Paul: Well, the latter few questions that I have are mainly dealing with things that concern your own interest in physics, maybe to help other people learn…

Professor #9: Right.

Paul: …learn from other professors or other physicists. But, when did you become interested in physics?

Professor #9: I think when I was in grade ten, I think what really got me interested…I was reading some popular science books, and they were great. I mean, I learned a lot about physicists' work and how discoveries were made. And, I was very fascinated. And, then I went to what is called "eleven" and "twelve"…high school. And, we had great teachers. So…and, uh, my…I wanted to always…I was good in math, I wanted to, you know, carry on in math. And, really, the eleven and twelve, those teachers changed—I wanted to apply math to, you know, physics.

Paul: Um hmm.

Professor #9: So, instead of just doing research in pure math, I wanted to do, you know, just apply it, too. And, they were excellent teachers. So, you know, those teachers make a big difference. [laughing softly]

Paul: Yeah.

Professor #9: And I would say that, you know, those two years I changed…I wanted to do math, [then] I said, “No, I have to do physics, and that’s what I want to do.” And…

Paul: So, by high school, you knew that you wanted to be a physicist?

Professor #9: I absolutely…and, that’s…that’s, you know—very early, I knew I wanted to be a physicist; I knew I wanted to do high energy physics; I knew I wanted to do particle physics, because I had read about it. I mean, I knew I had to learn a lot, but, you know, the whole idea of what these people were doing was just… I mean, it just fascinated me, and I knew I could do it. And when I had the teacher, the great teachers, I did well. And, I knew that maybe I could learn this stuff, and actually do something.

Paul: Yeah. Well, what were the important factors that allowed you to be successful in physics?

Professor #9: One of the things is you need to have good training. Of course, the first thing is, you know, you should have an interest…you should really have an interest. So, if you are interested, then you feel like working, you know; it's not that "I have to work because this"…no…people are working all the time because it's not that they have to do this, [it's] because they like it. And so, the first thing is: get interested. Because, when you get interested, you just work. And, I think it's also important, no matter…I mean, you might have an interest; you are willing to work hard; but you need to have good trainers and good professors, good teachers. Those are very important, so I was kind of lucky to have them. And, I think, uh…so, those are very important.

Paul: OK. Well, what…the last question…I'm wondering…like…let's say if there was a young student who was interested in physics as a profession, and he's interested in whether or not he can make a living and whether or not it's a good profession to be in, what might you say to a student who was interested in being a professional physicist?

Professor #9: Yeah, I mean, with a degree in physics, not only do you get a degree, uh…a job in which is physics, you can…you can go to any other branch, whether it's medicine, whether it's computers. My wife had a degree in physics, then she went to computer science; and then she was working for IBM. And I remember…because, with a physics degree, you just do things differently…and once, her manager came…because, the way the computer science people think [compared to] the way the person who comes from a physics background thinks is very different…and, the manager was so happy because, he said, "You're the only one who actually makes a model, makes an effort to really understand what is going on instead of blindly trying this and that and this and that." So, it's just that physics education makes it so much, uh…your thinking is so much more different than…and it, uh…that it helps you in any field. Doesn't matter whether you are going—so you might take a degree in physics, then you might go and decide to go in medicine, or you might go in computer science, or finance. But, uh, the way that you are taught to think in physics is going to help you. I mean, so the thinking is very different. So, good students, like in India and China, are going to go into physics.

Paul: Um hmm.

Professor #9: Because, even though, um—a lot of my friends in undergraduate who were in physics: one of them is a big manager in Microsoft, one is doing something else, and someone has gone to medicine. But, as a good student, your default was to go to physics, because with a background in physics, you can pretty much do everything. And so, it's a very, very good investment to actually have a degree in physics.

Paul: OK.

Professor #9: You can always branch up to anything, and the physics education will really, really make you better than, on an average, better than the rest of the people.

Paul: OK. Well, I thank you for helping me do this interview today…

Professor #9: Sure.

Paul: …and unless if you have any further comments or questions, I guess that's the end…

Professor #9: OK. That's fine. Glad to be part of your project.

Paul: Yes sir. Thank you.

Interview with Professor #10, Physics Professor at the University of Mississippi (Summer 2012)

Paul: In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places, as far as you know?

Professor #10: This is a difficult question. I think that…well, it depends on a case-by-case basis. But, overall, if I have to average on all the students that…graduate students that I had dealt with in the past few years, I would say that, overall, they are not. So, other…students from other regions of the U.S. or from other countries, if I had to compare them with the performance of Mississippi students, I would say that the

Mississippi students are not prepared for graduate classes when they first start. But, as I said, it depends on a case-by-case basis.

Paul: OK. Well, this is a similar question—slightly different—but, if you have any experience with this, the question that I would like to ask is as follows: how do American students compare with international students, in your opinion?

Professor #10: Um, so yeah, this is a similar question; and I would say that it's even more difficult than the previous one, because America is very diverse. And, also, in higher education, it's very diverse. So there are some regions of the U.S., like the Northeast or the West Coast, where education—higher education and even high school education—may be significantly better than other regions of the U.S. So, it depends on the institution that we are talking about. For example, I know that places like MIT or Cal Tech or the University of Chicago have students that are very competitive, compared to international students.

Paul: Um hmm.

Professor #10: So, I would say that there is no difference between international students and American students, on average.

Paul: OK.

Professor #10: There are other regions of the U.S. where you notice a difference. And, I think that this is mainly due to previous education. Well, again, it depends on a case by case basis, it depends on the motivation of the student, but…um…a big deal follows from previous education. So, I would say that I can't really answer this question. In some regions or for some institutions of the U.S., I think American students compare very well with international students. And, for other institutions, other regions, I see a difference, and in general…in general, American students are less competitive compared to international students.

Paul: OK, and I think you sort of answered that, but just to…just to make sure that you had a chance to answer this part…like, if there is a difference…like, if I understood you right, the main difference you said was previous education, but is that correct?

Professor #10: I think so. I think so. For example—well, just to go back to question number one—I don't think that in Mississippi the educational system can really prepare students for graduate studies in physics. And, this is very different from, for example, for other states. Of course, [that] doesn't mean in New York state all schools in the educational system is…uh…works well. But, there are differences. So, I think the difference, when there is a difference, comes from the educational system…

Paul: OK.

Professor #10: …which in turn is related to the culture.

Paul: Yes sir.

Professor #10: So, there are regions in the U.S. where science is valued more. So, of course, this leads to a better education in science and so on.

Paul: OK.

Professor #10: That would be the difference.

Paul: Well, what I'm wondering…this is just…happened to come to mind, but, the way…and I may view the U.S. wrong…but, I also, like you, think that there are certain cultures which basically value education very strongly…and it doesn't mean they are better or worse people, but they start at a young age, and by the time they get to graduate studies, they are, I guess you could say, "ahead of the curve." Is that correct?

Professor #10: That's correct. There are cultures where education is valued more…

Paul: Yes sir.

Professor #10: …than in the Western society; and, not only education, but really, the profession. For example, in Eastern cultures, being a teacher is regarded as very valuable in the society. But, in addition to this, which is a general view, also science, and careers in science, and education in science can be seen differently in different regions. For example, there are regions in the world, cultures, where science is regarded as a very good thing to do.

Paul: Right.

Professor #10: And, there are other regions where science is, you know, there is even a sort of antagonism to science in some regions.

Paul: Right.

Professor #10: So, there are two things here: the education in general, and the science part (which is…I think it's even worse in this respect).

Paul: Yes. Well, I was wondering…like…since you…like…I guess what I'm saying is…is this true, in your experience, do you believe this is true in Europe also, that there is such a difference in, like, certain sections of the country is this way and then another section is this way, is that more of an American thing where this is really prevalent, or is that also in Europe, there's elite schools and then schools that are just general?

Professor #10: There are differences in Europe, too, definitely; but much less than in the U.S. So, it's more…Europe is more homogeneous. In the U.S., you see the differences much, much more.

Paul: OK. That's what I…I…I thought that, but I wasn't sure.

Professor #10: Yeah. I mean, differences are everywhere, OK.

Paul: Yes sir.

Professor #10: There are some countries in Europe where education and then science is less valued than in other countries. But, overall the differences are much minor. So, I cannot think of a country in Europe that...uh…I mean, of two countries in Europe with [as] huge of differences as two regions of U.S.

Paul: OK. Well, this is a slightly different question, but do economic factors play a large part in students choosing to pursue or not to pursue graduate studies in physics, and are there differences from country to country?

Professor #10: I think they do. I don't think this is the only factor, but I think it's certainly a factor. For example, a career in…more generally, [an] academic career doesn't pay so much as a career in industry or some other professions. So, especially for young people, they are looking at these kind of things, "So, what are the prospects?" and then so on. This is true not only for physics; it's true in general. But, uh, in the case of physics, uh…it happens in physics, too. I mean, if there is a possibility for a career in computer science that has a starting salary which is twice the starting salary of a physicist, then that certainly makes a difference. And, if these factors vary from country to country…well, again, uh, probably yes: there are countries nowadays that are investing a lot in science and physics. So, that may make a difference. As I said, this is not the only factor. It's more of a cultural factor, [an] educational factor, and so on. But, certainly, yes, it plays a role.

Paul: Well, one thing I had thought about—and I never find this in physics journals of education much—but, I know, from living here in America, that many…for example, many Mexican workers come here because of exchange rates difference, which makes it very more…I guess, "doable," for them to do low-level jobs that don't pay well (like, let's say, mowing a yard, or such), but then if they carry the money back to Mexico, it's actually worth a lot more than it is in America due to exchange rates. And I've wondered—and I've never read this anywhere—but I've wondered if even in physics…let's say that…one of the things…I know that many of the cream of the crop of American students often look at lawyers or doctors, but I see in America many foreign students that come here—and very hard working students—but often they're from countries with exchange rates that are lower. And, if you look at the—let's say, like, the Netherlands or somewhere—you don't, for some reason, you don't see their students coming to America to study as much. Is it…could it be, possibly, that some kind of deep economic reason may make it more worthwhile, or is that just totally off-base? I'm just…I'm just wondering.

Professor #10: No, I don't think that plays any factor. I don't think that's a cause. Students, for example, who are interested in science or physics, they tend to go to the place where they can produce more, the place which is the top place. The fact that we don't get many students from abroad anymore, who want to do physics and science in general…uh, from, uh…from, [for] example, from Europe, is due to the fact that, uh, I'm afraid that American universities are not competitive anymore as they were thirty years ago.

Paul: OK.

Professor #10: And this starts to be true, also, for other developing countries. For example, I'm afraid that we don't get anymore, the best, say, Asian students or the best students from the Indian subcontinent and so on; because, those countries are investing a lot in science and physics. So, I don't think that it's related to economic issues.

Paul: OK.

Professor #10: It may play a role that, of course, if a person comes from a country where the economy is more struggling, then he can come to the U.S. But, I think that for these kind of jobs, people tend to go to places where they are sure that they can produce, can produce more. So…

Paul: OK.

Professor #10: …I mean, that's my, uh…my opinion….

Paul: That's a very difficult question, and it's one that I don't even know the answer to. [laughing]

Professor #10: Yeah.

Paul: It's just something that I've noticed, and I've even talked with a few foreign students about it—a little bit. Just…this is not really deep research…and some did say that there's…like, some of the ones from lower countries, said that—I mean, I don't want to put words in their mouth—but basically, it is worth more, the money here, if it's carried back to their countries. And then, some of the ones…I have talked from a…a European student that said that he's losing money by…by…basically, when he carries ten thousand American dollars back to that country, it's worth, like, basically nothing [laughing]…so…or, not nothing, but less.

Professor #10: Yeah. It would be interesting to see how many students actually go back or bring…

Paul: Yeah, or have anything.

Professor #10: …bring money back, because…

Paul: They save…

Professor #10: Yeah.

Paul: …they try to save very much…but…but it's…I don't know, but I think it's worth looking into, because whenever—all physicists want to understand the full picture, and it just helps us understand the full picture better; but, it's not against any group, because they [are] very hard workers…from all…Americans…anyway, that's a whole other story.

Professor #10: I would say that being a graduate student in the U.S. certainly does not allow you to save a lot of money…

Paul: …not a lot…

Professor #10: …to bring back to your country…

Paul: Exactly.

Professor #10: …assuming that you go back.

Paul: Exactly.

Professor #10: But, my impression is that most of the students who come here from foreign countries—they eventually stay. And, so I don't see it much as an economic issue. If you think about the amount of money that you can save compared to what's your income…

Paul: Right.

Professor #10: … it's very small. So, what you can…for example, this [is] sort of a digression, but sometimes you hear the discussions say, "Oh, immigrants come here and," (let's say from Mexico), "and then they work, and then they send their money back, and this is a drain to the economy."

Paul: Um hmm.

Professor #10: But, if you think about the amount of money that…it…how much is a few percent of the income? So its, uh…

Paul: Right.

Professor #10: Yeah. So, I don't know, maybe talking to graduate students—that would clarify more what they had in mind.

Paul: Yeah. And, I didn't know if, like, even being a…I mean, it may not be, there may be nothing to it. It's just another aspect of physics education; it's important to understand; but it's—because economics, the more you study—I'm sure that you know how much that's in society and affects so many things. But, anyway, that's a very difficult question. That's something maybe another researcher can pursue further. [chuckling]

Professor #10: [chuckling]

Paul: But, what could be done, in your opinion, to make the Mississippi education system better for producing highly skilled science and math students? In other words, if you were the "dictator of education"…[laughing]

Professor #10: [laughing] …the "Czar of Education"…

Paul: …what would you say, like, to do to make it better for producing students that would be ready for you all, and…and…you know, very good students?

Professor #10: I think that the educational system in Mississippi has to be improved, but has to be improved from "K" [kindergarten] [inaudible word/s] first, and then high schools, and the middle schools, high schools, and so on. I think that the educational system in Mississippi—it's not at a level to produce highly skilled science and math students in Mississippi. I don't want to put all the blame to the teachers. But, certainly the system does not work. There are very few teachers with science degrees, very few with physics degrees. If you have teachers who are not prepared, then they cannot prepare students. So, if you have a teacher that doesn't know anything about physics, they cannot teach the students physics; and, the students will never be interested. And, if you have teachers who are not well-prepared, who don't know the material; they cannot teach effectively. If you have curricula that do not put emphasis on science, you cannot produce students. So, I think that unfortunately if I were the dictator, I would overhaul completely the educational system in Mississippi. And, of course, there is also the cultural issues.

Paul: Right.

Professor #10: So, we are not living in a society where science is valued…I mean, by…in general, too much. But, I think the educational system would have to be better and more teachers.

Paul: Yes sir.

Professor #10: And, this also involves paying teachers more; because if a salary for a teacher is not comparable to a salary in another profession, the best people will not go to teach. A couple of years ago, I taught a physics summer school, and a few students, they asked me, "So, if I get a degree in physics or astronomy, what can I do?" And, before I could answer, they stopped me and they said, "I don't want to teach. I don't want to become a teacher, because I see what my teachers right now are doing, what's their life…" and so on, "So, what can I do besides becoming a teacher?" So, if we have fourteen/fifteen years-old [students] thinking like that in Mississippi, you don't get good teachers; you don't have a good educational system; you cannot prepare high on the scale [for] physics. So….

Paul: Well, the latter few questions—the latter two or three—are mainly about your own life, as far as to help people understand what makes someone be a good physicist, or what makes them interested in physics. But, when did you actually become interested in physics?

Professor #10: Oh, I became interested in physics and astronomy when I was very young. My dad gave me, for one Christmas—I think I was probably six or seven years-old, eight years-old—a small telescope; and then I got really interested in astronomy; and then, in order to do astronomy, you need to do physics. So, I became interested in physics—but, at a very early age. And so, this again relates to what I said before. At least in my case, there were two important factors. One was the cultural factor. So, the fact that my parents realized that science is something important, and so, they gave me the telescope. If you are living in a society where science is not valued, you cannot really get people interested.

Paul: Right.

Professor #10: So, that's a cultural factor. And, the second factor is that I was always helped, in pursuing science, from my teachers…in elementary school, first; in middle school, high school. It was a very good educational system where in high school I took many classes of physics—also high-level classes. And I always had the support of the science teachers and so on. So this is the second factor. There is a cultural factor and [an] educational factor. And, I think that you need to have both…

Paul: OK.

Professor #10: …to…um, at least in my case, that was my personal case. Somebody may become interested in physics when they are twenty years-old because of other reasons and so on; but, if there is not some background basis, both educational and cultural, then I think it's more difficult.

Paul: Right. Well, the next question is very similar, and you may have already answered it, but what—if you had to say—what are the important factors that allowed you to be a successful physicist (or successful in physics)?

Professor #10: Yeah, the question is similar. So before, I said what are the factors that made me interested in physics.

Paul: Um hmm.

Professor #10: What are the factors that made me successful in physics? Well, one was, as I said, the educational system; and I always found very good teachers; and that they motivated me; and they also, they knew their jobs; they knew how to teach. And, the other factors, of course: one has to be motivated; you should not think too much about your career, or your salary, or when eventually you will get a position. So, more personal factors, essentially…more personal things play a factor. So, you have to start—it's like a race—you have to start well, and then…but you have to keep your speed, OK. [chuckling]

Paul: Right. [chuckling]

Professor #10: So, you need some stamina—at least to keep in. Otherwise, you will not win.

Paul: Right.

Professor #10: So, starting well is the cultural thing and the educational system; and then your stamina is up for yourself.

Paul: Right. OK. Well, if you—this question deals with if the physics profession represents a profession in which Mississippi students can realistically obtain a well-paying job, with satisfying job conditions. So, what would you say to a young student in

Mississippi that was interested in being a physics major—like, if he was trying to decide should he or should he not—what would you say to him?

Professor #10: I would ask him or her a question: do you want to stay in Mississippi, or do you want to go somewhere else?

Paul: Right.

Professor #10: Because, if a student wants to stay in Mississippi, then I don't think that person can get a well-paying job in physics, with satisfying job conditions and so on. I mean, yes, certainly you can, because there are always the exceptions, OK. But, overall, I would say probably no.

Paul: Um hmm.

Professor #10: But, if you are willing to go somewhere else for your career, or live somewhere else, and to other areas—yes, certainly…certainly yes. I mean, it's not that coming from Mississippi puts you at a disadvantage and so on. But, um…so, my answer would depend on that.

Paul: OK. Well, I thank you for the interview, and unless if you have any further comments or questions, that's…I guess that's the end of the interview.

Professor #10: No. I think it was very nice, and it's very helpful also to me to think about these kind of things. So, it was very nice. Thank you.

Paul: Thank you.

Interview with Professor #11, Physics Professor at the University of Mississippi (Summer 2012)

Paul: In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places…in your experience?

Professor #11: Well, we don't get too many Mississippi native students in the graduate program. As far as I know, I think we have one or maybe two in the program right now that are native Mississippians, so it's a little hard to tell. I know that one is struggling a little bit, but that's just one data point. So, I don't think we really have enough data to know if Mississippi students, in general, are prepared for graduate studies.

Paul: Yes sir.

Professor #11: I do know that we have placed several undergraduate students, coming out of our department, into other graduate programs. And, they're doing well. There's one at Virginia Tech. He's the only one I can think of off the top of my head, but I know there are several others. So, I feel like that we're preparing our undergraduate students here at the University of Mississippi; the motivated ones—sort of the, you know, top tier ones—are perfectly well-prepared for graduate studies at other places.

Paul: Yes sir. OK. In general, how do American students compare with international students, in your opinion? And if there is a difference, what may be the reasons for these differences? And if there's not, then…we could go with that.

Professor #11: Well, you know, in general, the Asian students typically have a stronger mathematics background. There's no question about that. I do find, however—being an experimentalist—that American students are often better in the lab. They have a little more hands-on experience. Umm…and…now, I have to say that that's all sort of right at the beginning of their graduate work. But, as they progress in the second, third, fourth year of their graduate work, typically those things kind of even out. So, the U.S. students tend to get up to speed with the mathematics. And then, the Asian students tend to get more creative and get more comfortable in the lab with hands-on experience. So, that's sort of where things start, but as they progress I would say they even out pretty well.

Paul: OK. Well, I was wondering, and many of these are—the plan is to get much input from many physics professors, and then see if there's commonalities—but what I was wondering is: what, if you had to make a hypothesis, what might be the reason that possibly, let's say, the international students may come in with a stronger math background?

Professor #11: Well, they just have a much more rigorous, broad, mathematics curriculum before they get here. And, um…the reason for that—it goes all the way down into the elementary school…elementary school level. You know, it's unfortunate, but a lot of the U.S. high schools are really losing skill and offerings…opportunities at the higher level mathematics; and, also, particularly in physics as well. I know in—this may be a later question—but I know in the…that the Mississippi high schools, and high schools across the country, but I think it's particularly a problem in Mississippi, is: finding qualified people to teach high school physics. But, that's not a problem in Asia and Europe. I mean, there's good, high quality education going on in math and physics at the high school/secondary education level, as a general rule. And so when they get into university, they've already seen a lot of physics. They've already seen, you know, pretty high levels of mathematics. And so they're ready to go move on to the next level.

Paul: OK. Well, this question—it may be sort of difficult to answer, I'm not sure, but—what would you say about economic factors? Do economic factors play a large part in students choosing to pursue or not pursue graduate studies in physics?

Professor #11: I think that there's some factor there, but I think it's a smaller factor than many other fields. I think physics is the kind of career you choose because you love to do it, not so much because you hope to make a lot of money doing it. It's a lot of work, and the typical physicist doesn't make a ton of money. There are exceptions: those that go to work for private industry and quickly move up ladders, and they get quite high salaries; or those that invent some device or service or whatever, that end up making a lot of money. But, that's the exception, by far, not the rule. Most physicists go into academics, or they go into research in private industry. And, the salaries are reasonable, but they're not going to make you rich. But they do it because they just love physics. They love to do that, and so that's what they—you know, they're plenty smart enough to probably make a ton of money in finance or something like that, but that's not something that they love to do.

Paul: OK. Well, one of the things that—and I don't know if you have any, I guess, experience with this to really say, but—I've wondered about exchange rates. Like...for instance, the very thing that makes it, I guess you could say, "lucrative" for Mexicans to work at low wages and makes it more, I guess, more "promising" to them as a career—I wonder if those factors may come into play in, let's say, graduate physics studies; because I've noticed that even in American schools, many of the foreign students who come here actually are not from the places where the exchange rates are higher with the American dollar, but possibly from places elsewhere [where] it is lower. And, I don't know if this is just a coincidence or if there is possibly something that makes the career more doable for, maybe, students—and maybe less doable for American students. And, some of this is my opinion, but I don't know if you have anything—have even considered that.

Professor #11: I don't really follow the exchange rates very closely, but they vary a lot. And, I would think that if that was a prime motivating factor, then physics probably wouldn't be the choice for a particular career. You know, I mean, just because the kind of differential between, you know, doing something like—you know, for a high quality student that's going to get accepted into a physics program, they could likely also be accepted into a great business school or something like that, in which case their earning potential is much greater than physics. Now, it may be a secondary factor. I know that there are certainly foreign students that come to the U.S. because, you know, the salaries—the cost of living in their home countries is a good bit less than it is here, and so comparatively, the salaries for a working physicist in the U.S., you know, would be quite high compared to, you know, the cost of living in their home countries. And so, that may be a secondary factor to come to the U.S. to study physics as opposed to going to some other country.

Paul: Yes sir. Well, I know that question is…some of that is just really theorizing on my own, but I know that, I guess—I've thought about it—I know that, in my experience, many of the most promising American students go into lucrative fields like medicine or law; and I wonder, to an international student, if physics (to them) is such a field if the, somehow, the exchange rate would make it worthwhile for them to make that few years sacrifice. But, I don't know…like…that's just…that part is just my own…I was just asking, like, a few professors concerning that.

Professor #11: Um hmm.

Paul: But…what could be done to make the Mississippi education system better for producing highly skilled science and math students?

Professor #11: Well, I don't think there's any secret here. I think that…there…really, actually I think there are two important factors in that. And, one is getting high quality instructors into the high schools. And, you know, here in Oxford, and in Jackson, there are some very high quality instructors for math and science. But, you know, out in the rural areas, which is most of Mississippi, it's extremely difficult for them—for those school districts—to get physics teachers that are actually trained in physics. What they typically do will get somebody maybe that was trained in math, or trained in, you know, engineering maybe, or even something more far afield like computer science or something like that. And, because it's vaguely technical, they'll ask them to teach physics. Or, you know, even worse: nobody wants to teach physics, so the football coach or somebody just kind of gets stuck teaching physics.

Paul: Yeah.

Professor #11: And so, that's a major issue, I think. But there's also a second issue which is the culture, the home life. I mean, you can get all the great instructors in the world into these positions, but if the students are not motivated to pursue these fields and take these courses, then they're not going to; and, even if they are, you know, they may not be either willing or motivated enough to put in the effort to be successful at them. So, that's another issue, I think—equally important, actually, [to] getting the good instructors in place is having a culture within the communities that supports these kinds of courses and pursuits…career pursuits. And, so anyway, I think those are the two main factors.

Paul: OK. Well, the latter few questions are mainly dealing with trying to understand what motivates people to go into physics, so that future people that read it—maybe they can see commonalities amongst the various physics professors or physicists. But, when did you become interested in physics?

Professor #11: Well, I don't know that I can put a real specific date on that. You know, when I was a kid, I used to love to hook up string and pulley systems, and I'd have stuff strung up all over my room and hooked to my dresser and all that—you know, building simple machines and that kind of stuff. I had some interest in electronics, as well. And, you know, when I first went to college, I actually wanted to go into physical therapy or surgery, and so I was a pre-med. And I took my first—well, I took physics in high school and did well in that and enjoyed it, but didn't really think about it as a career. And, then I took my first physics course as part of my pre-med program as a freshman at the university (and, also along with all the other pre-med stuff you've got to do, like intro chemistry, and biology, and that kind of stuff). And, I just quickly figured out that physics was my favorite course that I was taking. And, so I started, you know—that's really when I decided that physics was the way to go. And, you know, even then, I still had in the back of my mind that—the university where I was, there was a health physics program or track within the physics department, and…and so that's kind of the direction I was still looking to go. But then as I got toward, you know, my upper level courses and stuff, I decided I really just enjoyed the pure physics, and then decided to pursue that.

Paul: OK. Well, what were the important factors that allowed you to be successful in physics?

Professor #11: You know, I think that it takes a lot of work. It takes a lot of work to, uh—the material is not easy. It's not easy for anybody. I'm no raw genius, in terms of the mathematics and things like that; and so I had to work hard at learning that material. And, so, that's part of it, and really just—but, I think the real key bit is that you have to take pleasure in that work. If it's just work, then you're never going to succeed. Because, you know, you'll burn out.

Paul: Yeah.

Professor #11: And, so at some point, there has to be this, you know, genuine satisfaction, enjoyment, of solving that problem, understanding that material, getting that program to work, getting the bugs worked out of an experiment, seeing that first data roll in after a year of building up an experiment. All these things are—you have to have a genuine sense of satisfaction through those milestones. And so that's the motivation that keeps you going through the next year of building up a new experiment or working on a new calculation. And so, those two things, I think: just a genuine enjoyment of the field and the work; and a willingness to put in the time and not—certainly not—think of the time versus money equivalence.

Paul: OK. Well, I was wondering about the physics profession as being a realistic profession for students, with satisfying job conditions. But I was wondering, what would you say to a young person who was, you know, interested in majoring in physics as a career?

Professor #11: As you may know, our largest group of undergraduate physics majors are pre-meds. And, one of their main motivations is getting into medical school. And, we have an extremely high acceptance rate in our pre-med program—"ours" meaning "the physics department." It's in the high ninety-percent range. And so…and I bring that up as an example because there—an undergraduate degree in physics does prepare you for a lot of technical fields—and there's a lot of, you know, both professional programs and other graduate programs that love to get undergraduate physics majors because they have been trained well in how to solve problems and to understand that the solution to a problem is not necessarily going to come in half-an-hour of thinking and working, but it may take hours and hours, or days and days, or weeks and weeks. And…so they have both the analytical tools and the understanding of the process, the problem solving process, that makes them well-suited for a lot of different technical fields. So, there's a lot of opportunities for [an] undergraduate physics major other than pursuing a career in physics proper.

Paul: OK. Well, I thank you for the interview today, and unless you have anything further to say, I guess that concludes our interview.

Professor #11: OK.

Paul: Thank you.

Professor #11: Thank you, Paul.

Interview with Professor #12, Physics Professor at the University of Mississippi (July 2012)

Paul: In your opinion, or in your experience, are Mississippi students as well-prepared for graduate-level physics courses as students from other places? In your opinion.

Professor #12: Well, I haven't talked to students from those other places, but just based on the anecdotal information, my understanding is that they're not quite as well-prepared for graduate level…but, I don't have a lot of experience to base that on.

Paul: OK.

Paul: In general, how do American students compare with international students, in your opinion? If there is a difference, what are the reasons for these differences? And, if there is not, then I guess it's a moot question…but…so, how do Americans compare with international students, in your experience?

Professor #12: Now do you mean in the same classroom here? Or, do you mean comparing all over the world?

Paul: I think…basically…in the classroom, as far as, have you noticed a difference? Or is there a difference, in your opinion, in the classroom here, really?

Professor #12: Well, we tend to get very highly motivated students from international programs, because we select students that are highly motivated. And, we have more applicants than we can possibly…you know, that we can possibly take…

Paul: Um hmm.

Professor #12: ...from international pools. So, basically, we're sort of self-selecting the students that are more aggressive. And, that means that at the graduate level, there's higher competition in our graduate schools as a result.

Paul: Um hmm.

Professor #12: And so, that's good for us, but at the same time, um…it's…I don't think U.S. students are as hungry to achieve something. I think they're content to play with Gameboys or their telephones or whatever, and don't really have the fire in the belly that a lot of the international students do that are sitting next to them in classes. And so, I think they don't perceive academics as the way to really achieve life goals to the same degree that internationals do. And, I also don't think that U.S. students honestly believe that they're—in their lifetime—they're going to be competing meaningfully against the whole world.

Paul: Um hmm.

Professor #12: When in fact, you know, if the engineering isn't good in this country, somebody else is going to get the engineering work to do. So…

Paul: Um hmm. OK.

Professor #12: …anyway.

Paul: Well, do economic factors play any part in students choosing to pursue or not pursue graduate studies in physics? And, do these factors—if there are these factors—do they differ from country to country, the economic factors?

Professor #12: Well, I think that must be true that the economic factors matter. I think, in part, a lot of it will be what your parents' expectations were for you. When I was still a child, my mother was talking to me about what I should do about graduate school. Now, that was before I had even thought about selecting a college and stuff like that, but she was saying…how to fund graduate school—way back then. So, I already knew that my expectations, on the part of my family, were: someday I should be in graduate school. So….

Paul: Um hmm.

Professor #12: Umm, so I think part of it is the expectations that are placed on you, and part of it is the opportunities that present themselves. I mean, if you want to be in a graduate program in many disciplines, you have to pay your own way. And that's…for some people, that's prohibitive. And, for example, lots of people who are married find that they can't get the family to survive on a teaching assistantship. So, you know, they may not be able to continue in their graduate studies because they can't fund it. So, all of that matters. Yeah.

Paul: OK. What could be done to make the Mississippi education system better for producing highly skilled science and math students?

Professor #12: Well, based on my brief experience of [close acquaintances I know who have been] in high school, I don't think that enough is demanded of the students.

Umm…unless they're already motivated, and unless they say, "OK, I'm going to take four or five AP classes," there isn't the discipline, you know, to force them to use their mind, to force them to really exercise the intellect. And they may never discover that there's uplift and that there's inspiration in using your mind for serious scholarship. And, the other thing is, umm…what I see, not to put too fine a point on it, but there does seem to be quite a bit of chaos in the classrooms…

Paul: Um hmm.

Professor #12: …even in the better schools. The things that absolutely would not have been tolerated in my own elementary school are going on all the time, and same in the high school. That…

Paul: Um hmm.

Professor #12: …umm, that there's a, you know, a low buzz of other activity, of people minding their own business and holding their own conversations—over the lecture! I don't let that go on in my college classes, but the students do attempt to do that.

Paul: Um hmm.

Professor #12: So….

Paul: OK. What were the factors that caused you to be interested in physics? And, you know, what was it that got you along the path to be a physicist?

Professor #12: Well, I think it was partially this: the books that we had in our house. Somebody had brought home a couple of books on scientific experiments you could do on your own, and to me, those were like a catalogue of, you know, like looking through a catalogue of toys. I would look at these books, and then go off and try to do some of the things on my own—sometimes successfully, sometimes not. But…I just had a natural bent that way. I was interested in gadgets, and I discovered that the explanation for the gadgets was in physics. And that was how I got interested in physics.

Paul: I'm just curious—because you mentioned that your parents had high expectations, it seems—were…were your parents, were they, uh, maybe like graduate-level educated or college educated? Or, what do you think was it…

Professor #12: Well, they each got a doctorate, but after I did.

Paul: OK. [laughing]

Professor #12: My mother got a doctorate at the age of 62, and my dad at like seventy-something…long after I did. But, uh…and my brother is a PhD in linguistics.

Paul: So that's strange…like, what would you consider the…the thing that impelled your, you know, your parents or your family to be so academic?

Professor #12: Oh my!

Paul: That's a complicated question! [laughing]

Professor #12: [*A few words were blocked out by the laughing*]…grew up in a...I mean, we all went in different directions. One of my sisters has a master's in English, and another in…um…psychology. And, we all went different directions, but there was an expectation that you weren't going to sit on your hands, that you had to go somewhere, do something to make a name for yourself, in some measure.

Paul: Umm. OK. Well, seeing that you've gone so far in physics—I mean, definitely you have a lot of experience—and, what would be your…what would you say are the important factors that allowed you to be successful in physics? If you were advising someone, what would be the important factors you would tell them…that allowed you to be successful in physics?

Professor #12: Umm…persistence, I guess.

Paul: Um hmm.

Professor #12: [That would be] one thing. But, I think with physics, you have to love it, because the work is too hard if you're not motivated.

Paul: Right.

Professor #12: It's like climbing mountains, you know. If you're not motivated, it's not going to be any fun. You don't enjoy the views. So, that was part of it. And, I think I had the advantage of a very, very demanding elementary and secondary education. And because the demands were so high, I was really well-prepared to launch into physics as a major.

Paul: Um hmm. Well, if you were advising a young student that was trying to choose a career—let's say in Mississippi, a young Mississippi student—what would you tell them about physics as far as…you know…are there realistic jobs in the field? Or…basically, what would you tell a student who was wanting to…or thinking about majoring in physics…or choosing that as a career?

Professor #12: Well, I think it's almost a foregone conclusion that physicists will find jobs, but they don't always find them in physics. So…um…but there's a broad range of industries that are hiring physicists. Academic work is open. There are jobs. And, I think—I don't know how it is exactly now, but I would say ten years ago, the American Institute of Physics showed results of what…the earning power of people when they got out of a physics program as compared to when they got out of chemical engineering or civil [engineering] or whatever. And, you know, the physicists sort of came "in the pack"—lower than chemical engineers, but above some others. So….

Paul: Um hmm. OK. Well, do you have anything else that you might want to say about physics in general or Mississippi…Mississippians in physics?

Professor #12: Well, one thing that the state has done right is the honors college.

Paul: Um hmm.

Professor #12: And, the honors college has brought very talented students to the University of Mississippi, and they've gone a long way. I mean, some have gone to Oxford or Cambridge, and…um…these are students that are already motivated and have, you know, the…so I think it's a good chance for our state to develop our own talent, somewhat, and that's…that's good on all sides, I think.

Paul: OK. Well, I thank you for the interview, and I guess that's the end of the interview. So, thank you.

Professor #12: Sure.

Main Answers from the Interviews with 12 Physics Professors (Separated Out Question by Question)

The researcher, in the following pages, has listed each question from the interview form with the twelve UM physics professors [see *Qualitative Survey Form (Interview with Physics Instructors)* in Appendix C]. The researcher asked most of these questions (but not every single question in every case) during the interview with each of the twelve University of Mississippi physics professors (i.e. physicists). The full transcripts show the complete context of precisely how each question was asked to each professor. The researcher went through the transcripts and carefully selected out the "main answer" of each professor to each of the interview questions (from the interview form) which was asked of him or her. In the following pages, these main answers which the professors gave to the interview questions are displayed. This arrangement allows the professors' answers to the interview questions to be more easily seen and compared, side by side.

Main Answers from Interview with Physics Professors (Question #1):

(1) In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places?

Professor #1: No, I don't think so. In general, they are not really that well-prepared. One reason for that is that in other countries, I mean, there is already some pre-selection of the students who come to the university. Whereas, here we don't have that kind of a pre-selection. OK, anybody from the high school who comes can come into the university and take some physics courses here. And so, they don't have to be prepared for physics, in that sense.

Professor #2: Probably…the ones that actually get admitted; and I don't know all about the students that don't get admitted. So, the admissions committee looks at student applications and decides who to admit. And, then I just see them in class and in the department and giving talks about their research. So, we don't actually have lots of students from Mississippi. I don't know if that's because they're not well-prepared, or because they—if they are well-prepared—they might want to go somewhere else. But the ones that we've had have been reasonably prepared, I think.

Professor #3: Well, not quite as well-prepared, but they can do good. They can do good.

Professor #4: Well, we get students from Mississippi, other states, and abroad, and I've had strong students from Mississippi…just as from other states. I think, in general, that the students are qualified to go to graduate school, and they make it into graduate school. They can be as strong as students from other places. So, just on the surface, I can't say that they're particularly, uh, significantly weaker than students from other states or abroad. One can argue that maybe in some more detail, but there's not so many students going through the physics system, and so it may be a hard thing to gauge. So, that's not an easy question to answer.

Professor #5: Well…not having taught the undergraduates in Mississippi, it's harder to tell. But, I judge that more by who we're admitting; and either they're not coming here, or they're not as well-prepared, one of the two.

Professor #6: No. I can elaborate. […] What I've noticed, since I've been here, is that our own students seem to be less well-equipped to compete in the class work with the students that we get from other places. Most of the students that we're getting from other places are foreign students. We are getting more domestic students. But, what we've found regionally—there are a few exceptions—but, from some of the smaller state universities, regionally, they haven't been as competitive with the foreign students.

Professor #7: I don't think they are. In terms of graduate students, the students who come from Mississippi universities aren't as prepared as those…and I think that tends to be the reason why we end up getting students—outsourcing—students from outside the country and even students from different states.

Professor #8: This is kind of a hard question. For sure at Ole Miss, definitely what I notice is: there's a really wide range, first of all. […] You're going to find that some students from Mississippi are going to be quite well-prepared, and really do extremely well. But, I would say, overall, I think there is definitely a lack of preparation; and most of it is what I call "foundational knowledge." Not even about physics. Right? It's basically…OK…like, their math preparation might not be as good. And, just…I mean, critical thinking skills, I think, might not be as good. And, I generally think that's just because—and I don't know this to be true—but I suspect it's simply because whoever teaches in the high schools probably have the same problems, and it's not even the fault of the students, I often say. It's just…they go to school, and they do the best they can with what they get, and […] I would say, yeah, generally, I think their preparation is not as good.

Professor #9: We have students from other places who appear to be better prepared than the Mississippi students. We have had some very good undergraduates coming from Mississippi, and they did our undergraduate program […]. But for graduate students, I think, the standard has been not as good as we would like it to be.

Professor #10: This is a difficult question. I think that…well, it depends on a case-by-case basis. But, overall, if I have to average on all the students that…graduate students that I had dealt with in the past few years, I would say that, overall, they are not. So, other…students from other regions of the US or from other countries, if I had to compare them with the performance of Mississippi students, I would say that the Mississippi students are not prepared for graduate classes when they first start. But, as I said, it depends on a case-by-case basis.

Professor #11: Well, we don't get too many Mississippi native students in the graduate program. As far as I know, I think we have one or maybe two in the program right now that are native Mississippians, so it's a little hard to tell. I know that one is struggling a little bit, but that's just one data point. So, I don't think we really have enough data to know if Mississippi students, in general, are prepared for graduate studies. I do know that we have placed several undergraduate students, coming out of our department, into other graduate programs. And, they're doing well. There's one at Virginia Tech. He's the only one I can think of off the top of my head, but I know there are several others. So, I feel like that we're preparing our undergraduate students here at the University of Mississippi; the motivated ones—sort of the, you know, top tier ones—are perfectly well-prepared for graduate studies at other places.

Professor #12: Well, I haven't talked to students from those other places, but just based on the anecdotal information, my understanding is that they're not quite as well-prepared for graduate level…but, I don't have a lot of experience to base that on.

Main Answers from Interview with Physics Professors (Question #2):

(2) (a) In general, how do American students compare with international students, in your opinion? (b) If there is a difference, what are the reasons for these differences?

[*Note: During the flow of the interview for this question, the interviewer sometimes neglected to ask part (b) of this question. However, in those cases, the professors more or less addressed part (b) during the course of their full reply. Hence, all of the professors addressed part (b) of this question to various degrees, even in the cases where the interviewer did not actually ask part (b) of the question during the interview. One* *can observe the full transcripts of the interviews to get the complete context and wording of how the interviewer asked the various questions to each professor during the course of each respective interview; one can also see the full reply of each professor.*]

Professor #1: I think the international students who come here…they are, you know, they have come after some sort of a competition. So, they are some of the better students. Whereas, the American students here are just a general batch of students, not necessarily the top of the class. So, the foreign students who come here tend to be a little better than the American students, in general. But then, of course, the foreign students will be a small minority. And, you will always find American students who are as good as the foreign students. A few American students will be as good or even better than the foreign students.

Professor #2: I would say that the American students and the international students are comparable in the following way: there are some good ones in each group, and there are some others that aren't as good in each group.

Professor #3: We get quite a few international students wanting to go into physics, uh, but I think that the main difference isn't necessarily that they're better in physics. But…they don't have the interpersonal skills to get into business, for example. So they wouldn't necessarily be able to become MBA majors. Whereas American students can get into becoming an MBA major, get into law, get into a whole variety of fields…well-paid fields. And so, I think they tend to do that.

Professor #4: The international students…some can be very strong…and, as we admit international students, we have to be a little careful about the university they come from. So, they, in principle, have similar problems [that U.S. universities have] in training students, also. What we find is that most international students are more inclined to be more theoretically inclined, and so I can only guess that in some places they don't do as much laboratory work. I think one of the strengths, maybe, of U.S. students is that we integrate into our curriculum…even at the high school level…we advise that there be some level of laboratory work where students can get some hands-on experiences. And this is clearly true at the…even at the undergraduate level or at college or junior college level. We always encourage that students do lab classes with their physics courses. In fact, we require most of the…undergraduate requirements are that—even to go to grad school—we would require that the students take some laboratory work. When students come abroad, you really don't know what they've had in their background. Quite often, they're very strong on their standardized tests, but they can actually be…not know very much about laboratory situations.

Professor #5: Well, the international students tend to start concentrating earlier in specializing in physics or something. So, if they're going for physics, they start with math and stuff. And, for them, by the time they get into undergraduate, if not earlier, they're already tracked to do just physics. So, they're not taking courses in general education and the like because they assume that, like it used to be in this country, in high school you got enough of a general education.

Professor #6: I think it's their level of preparation. I think most of them come from places that have a stricter curriculum…that are…you know, it's obviously more demanding. One place that we see that is in GRE scores. There is a subject test in the GRE specifically for physics. And, typically, American students do not perform as well as foreign students on this. Now, there could be any number of reasons for that other than just pure ability in physics. But, I think the better preparation they may have—they're in schools that are probably much more focused on teaching than they are on research. And, you know, if you're not good, you don't get out of a foreign country to come to America. And that's another issue, as well, is: you know, if we're getting Chinese students—there's a huge population of Chinese students—and we get very good ones that make it out of China to other places.

Professor #7: In my opinion, there are two key differences. I think that foreign students tend to be better prepared in terms of academics. I tend to think that the foreign students come here already with a physics master's background so that they tend to bend the curve significantly. And so, you have American students who don't have any graduate level background to begin with in an introductory course. And so, the teacher tends to teach an introductory course at a more advanced level. And so, American students are competing with better prepared students. And I, I have a kind of a problem with that arrangement—those students should not be allowed in the same room with these students. Now there are completely new grad students from other countries—and that happens—but more often than not, you end up with students who have a much deeper background, because they're already walking in with a foreign master's degree. The key advantage that the American students have, compared to the international students, is that they speak the language. And, for teaching assistance purposes, the American students tend to do much, much better than the foreign students.

Professor #8: I think, generally, international students probably are better prepared, but it's not a fair comparison when you think about it. Right? Because, who are the international students that come here? The ones that are the best students in whatever country they come from. Right? And so, that's like a natural filter, I think. So, let's say you have students who come from China or India or whatever. Right? To go to American universities is not cheap. Right? So the ones who come here tend to be the ones who are the better students, generally speaking. And so, you don't get like the full sample of students from an international country that you get…as you get the full sample of students from United States, because students from the Unites States are going to come from everywhere. You get the full range. But with international students, there's a sort of natural filter where you get the best students. So, it's really not a fair comparison. My guess is: if you compare the full range, you're not going to get that big of a difference.

Professor #9: Well, I mean, there are obviously a lot of good American students; not all of them come to Mississippi. Now, the students that come to Mississippi, probably the international students—some are better prepared in their background. They have taken more science in their undergraduates. In their high school, they have taken more math. And so, overall, I think, generally the international students perform better. But, again, there are exceptions that have been very excellent. We have had many excellent American students who have done very well. […] So, first thing we have to realize that the students who come here are the best that are coming from the…because, you have to be really good to get a scholarship, and most international students cannot come here without a TA [Teaching Assistantship] or something. So, you get the best students. So, we are really comparing American students with the best students that are coming from the outside…the other countries. So, yeah, that has to be taken into account. I think, uh, I feel that the other thing […] so, for the international student, what is important is they look at the department, OK. They're doing good physics, and do they have good people? They're able to come? It doesn't matter whether it's in Mississippi or some other part of the country. For U.S. student, it's also important where they're going to spend the next five years of their life. So, some of them that…who probably don't see themselves living for five years in Mississippi, so they might go to some other place. So, there are other factors that come into their decision. Generally, I think, as far as the training is concerned, my experience—and, I grew up in a different country—is that there is more emphasis on definitely math in high school. Because, [some close acquaintances of mine] go to school here [at a school in Mississippi], and I always feel that there is not enough math or science that's being taught. […] The language of science is mathematics, so once you have a good grasp of that, it becomes very easy […]. If you are studying any subject, uh…if you are studying Shakespeare, and let's say you don't know English, then…you cannot do it. So, our language is math. You know, if you are very confident in math then the concepts and things, you know, you can express. […] Science is a very precise subject, so…and math is a very precise language. So, you should be able to express, you know, in a very clear way. And so, it's very important to have a good background in math. So, I think that…[in] my experience…I have experience of students growing up in [*two foreign countries were listed by the professor*], and they are definitely doing a lot more math than our students here are doing.

Professor #10: This is a similar question; and I would say that it's even more difficult than the previous one, because America is very diverse. And, also, in higher education, it's very diverse. So there are some regions of the U.S., like the Northeast or the West Coast, where education—higher education and even high school education—may be significantly better than other regions of the U.S. So, it depends on the institution that we are talking about. For example, I know that places like MIT or Cal Tech or the University of Chicago have students that are very competitive, compared to international students. So, I would say that there is no difference between international students and American students, on average. There are other regions of the U.S. where you notice a difference. And, I think that this is mainly due to previous education. Well, again, it depends on a case by case basis, it depends on the motivation of the student, but…um…a big deal follows from previous education. So, I would say that I can't really answer this question. In some regions or for some institutions of the U.S., I think American students compare very well with international students. And, for other institutions, other regions, I see a difference […]. I don't think that in Mississippi the educational system can really prepare students for graduate studies in physics. And, this is very different from, for example, for other states. Of course, [that] doesn't mean in New York state all schools in the educational system is…uh…works well. But, there are differences. So, I think the difference, when there is a difference, comes from the educational system…which in turn is related to the culture. So, there are regions in the U.S. where science is valued more. So, of course, this leads to a better education in science and so on. That would be the difference.

Professor #11: In general, the Asian students typically have a stronger mathematics background. There's no question about that. I do find, however—being an experimentalist—that American students are often better in the lab. They have a little more hands-on experience. […] Now, I have to say that that's all sort of right at the beginning of their graduate work. But, as they progress in the second, third, fourth year of their graduate work, typically those things kind of even out. So, the U.S. students tend to get up to speed with the mathematics. And then, the Asian students tend to get more creative and get more comfortable in the lab with hands-on experience. So, that's sort of where things start, but as they progress I would say they even out pretty well. […] They [the international students] just have a much more rigorous, broad, mathematics curriculum before they get here. […] The reason for that—it goes all the way down into the elementary school…elementary school level. […] It's unfortunate, but a lot of the U.S. high schools are really losing skill and offerings…opportunities at the higher level mathematics; and, also, particularly in physics as well. […] I know in the…that the Mississippi high schools, and high schools across the country, but I think it's particularly a problem in Mississippi, is: finding qualified people to teach high school physics. But, that's not a problem in Asia and Europe. I mean, there's good, high quality education going on in math and physics at the high school/secondary education level, as a general rule. And so when they get into university, they've already seen a lot of physics. They've already seen, you know, pretty high levels of mathematics. And so they're ready to go move on to the next level.

Professor #12: Well, we tend to get very highly motivated students from international programs, because we select students that are highly motivated. And, we have more applicants than we can possibly…you know, that we can possibly take…from international pools. So, basically, we're sort of self-selecting the students that are more aggressive. And, that means that at the graduate level, there's higher competition in our graduate schools as a result. And so, that's good for us, but at the same time, um…it's…I don't think U.S. students are as hungry to achieve something. I think they're content to play with Gameboys or their telephones or whatever, and don't really have the fire in the belly that a lot of the international students do that are sitting next to them in classes. And so, I think they don't perceive academics as the way to really achieve life goals to the same degree that internationals do. And, I also don't think that U.S. students honestly believe that they're—in their lifetime—they're going to be competing meaningfully against the whole world. When in fact, you know, if the engineering isn't good in this country, somebody else is going to get the engineering work to do.

Main Answers from Interview with Physics Professors (Question #3):

(3) (a) Do economic factors play a large part in students choosing to pursue (or not to pursue) graduate studies in physics? (b) Do these factors differ significantly from country to country?

[*Note: During the flow of the interview for this question, the interviewer sometimes neglected to ask part (b) of this question. Thus, in some of the professors' answers shown below, part (b) of the above question is never specifically answered by the professor due to the fact that the interviewer neglected to ask that part. In other cases, the interviewer did ask part (b) of the question, but the professor just never specifically addressed part (b) of the question in his or her answer. This could likely be attributed to the slightly confusing wording of the question, since it really has two questions merged into one question. Lastly, in some cases, the interviewer asked part (b) of the question in such a different way than shown above, that interviewer (P. Rogers) decided not to include the answers from such cases among these carefully selected "main answers" from each professor. However, there was still much good information gained from such interview discussions, even in the cases when the interviewer asked the question in too different of a way for the reply to be included among these carefully selected "main answers." One can observe the complete transcripts of the interviews to get the full context and wording of how the interviewer asked the various questions and how the each professor replied.*]

Professor #1: Well, economically, physics is really not that attractive. […] So, I don't think that people come to physics for economic reasons. So, I do not know—in our days, when we were studying physics, physics was not only economically interesting, but physics was, by itself, very, very exciting and very interesting. […] Physics is still interesting, but it is not as exciting as it was in the sixties or [early?] fifties. And, economy-wise, I think the business MBA students and so on, they get better jobs than physics people. The exciting fields, these days, seem to be biology, molecular biology, and information science…and so on. So, that's where the real intellectual excitement is. And so, probably, I think my, uh, brighter students might be going in those fields rather than in physics.

Professor #2: I don't really know. No one has ever come to me and said, "I chose to study physics because I think it's the way to make a lot of money." […] I think most students that are studying physics—my guess is—think that they'll get a reasonable job, but they're studying physics mainly because they like it and they think that they can get a reasonable job. I mean, you might like to eat ice cream all day, but that won't lead to a good job. So, I guess I think economics is a secondary factor in choosing to do graduate study in physics.

Professor #3: Well, the strange thing about physics here, if you come and major in physics, you'll probably get out of here without any debts. Because, there's actually support, even some at the undergraduate level with scholarships. Some…uh, there might be some teaching assistant openings even for juniors and seniors. Whereas in other fields, you actually wind up with owing bills after the end of your four years. So, I think the economic factors are sort of…geared even a little bit in favor of physics. At least for your first four years, you know.

Professor #4: Yes…uh…just in the U.S. or, uh, we can talk about Mississippi—maybe that'll be a question that's coming—but, as I said, even students coming abroad, you have to be very careful about the universities they are coming from. And, some of those universities are very rural, and they could even be—they may not be well-prepared. It seems that high schools and colleges that are preparing students in rural areas are at somewhat of a disadvantage, and that maybe they don't have the same level of resources. And so, typically the stronger students will be from universities that are in the larger cities, I would say…abroad. Although, you know, I'm from a small town [in a state in the U.S.], and somehow I'm now a professor of physics, and so there's a way to succeed if you work very hard.

Professor #5: Well, as far as country to country, they have to have enough money to get here. We'll start with that. But, once they've got enough money to get here, most of the graduate programs in physics, in the United States, offer support to the students, either in teaching assistantships or research assistantships—usually starting as teaching, and then later as research. So, it is possible to work your way through at least graduate school with an assistantship. Now, undergraduate…uh…maybe there aren't as many assistantships.

Professor #6: [*Note: During the course of the interview with Professor #6, the interviewer neglected to ask this particular interview question.*]

Professor #7: They don't tend to advertise it all that well, but I think the physics graduate assistantship is among the best on campus. I think it's much—I mean, leagues—better than English or engineering, and not many people realize that. That's a serious plus, that I consider, for this department is that: a graduate student in physics can live on their own in Oxford, Mississippi, and live comfortably. And so, that is not a problem.

Professor #8: I don't really know. I suspect that the main hurdle is the difficulty…of the subject matter. That's what I think. So, basically…OK, this is how I look at it, OK. This is my opinion. So, for [getting a] PhD in physics, you've got to jump this high [*Professor #8 motions with hand*], and then what you earn is this much money. So, if I get a PhD or even, let's say, a master's—an MBA or something—you have to jump like this high, and then you earn this much money. [*Professor #8 used hand motions to illustrate the various heights to which the students must jump, in this figurative analogy.*] So, most people are going to jump this high, and take this much money. […] So, I think it's more of the difficulty of the subject matter, and to some degree it is economic factors. But, I really think the difficulty of the subject is probably the biggest reason. That's what I think. [*At this point in the interview, Professor #8 was asked about economic factors and how they might differ from country to country; more specifically, in relation to this, Professor # 8 was asked whether or not differences in exchange rates might affect the economic conditions experienced by international students in comparison to American students. The following few sentences of Professor #8 are some of the main answers from that portion of the interview.*] I mean, there is a difference in exchange rates, but what I think is, you know, at the end of the day, what matters is: you know, what's the cost of living where you live? Right? […] I do think that the difference in what you earn between—not just physics, but really almost any science subject—and things like business, and finance, and even engineering…the gap is much bigger in this country than in most other countries. So, a physicist might earn decent sums of money—not going to earn money like the, you know, CEO of a bank or anything—but the gap between let's say just some guy who works in the bank…and he's earning nice money…yeah, he might be earning more, but it's not going to be like this big [*motions with hands*]. In the U.S., it will be this big; in most other countries, it will be smaller. So, I would think that because you don't have such a big gap in earnings—at least not as large—then, economic factors would matter less…in that case. I think it matters more here [in the USA]; just because it's just so much easier to earn a lot more money doing something else.

Professor #9: Absolutely. Yeah. Yeah, I mean…economics plays a big role, I mean, even among high school students, you see that high schools which are in some places where, you know, people are well-off—they tend to be better high schools […]. We see this in Mississippi a lot. So, yeah, I mean, the point is, everything has to start at…you have to start at the beginning, and I think everything starts from the first, you know. It's your parents, then your school. […] The problem we have is that when we have students coming in, they come with not that great a background. And, you can see a difference. The people who come up from better families tend to have better backgrounds; they have been able to go to better schools. And, others have…do not have a background, not because they’re not good enough, but they just didn’t get exposed to the training that they should have been […].

Professor #10: I think they do. I don’t think this is the only factor, but I think it’s certainly a factor. For example, a career in…more generally, [an] academic career doesn’t pay so much as a career in industry or some other professions. So, especially for young people, they are looking at these kind of things, “So, what are the prospects?” and then so on. This is true not only for physics; it’s true in general. But […] it happens in physics, too. I mean, if there is a possibility for a career in computer science that has a starting salary which is twice the starting salary of a physicist, then that certainly makes a difference. And, if these factors vary from country to country…well, again, uh, probably yes: there are countries nowadays that are investing a lot in science and physics. So, that may make a difference. As I said, this is not the only factor. It’s more of a cultural factor, [an] educational factor, and so on. But, certainly, yes, it plays a role.

Professor #11: I think that there’s some factor there, but I think it’s a smaller factor than many other fields. I think physics is the kind of career you choose because you love to do it, not so much because you hope to make a lot of money doing it. It’s a lot of work, and the typical physicist doesn’t make a ton of money. There are exceptions: those that go to work for private industry and quickly move up ladders, and they get quite high salaries; or those that invent some device or service or whatever, that end up making a lot of money. But, that’s the exception, by far, not the rule. Most physicists go into academics, or they go into research in private industry. And, the salaries are reasonable, but they're not going to make you rich. But they do it because they just love physics. They love to do that, and so that's what they—you know, they're plenty smart enough to probably make a ton of money in finance or something like that, but that's not something that they love to do.

Professor #12: Well, I think that must be true that the economic factors matter. I think, in part, a lot of it will be what your parents' expectations were for you. When I was still a child, my mother was talking to me about what I should do about graduate school. Now, that was before I had even thought about selecting a college and stuff like that, but she was saying…how to fund graduate school—way back then. So, I already knew that my expectations, on the part of my family, were: someday I should be in graduate school. […] So I think part of it is the expectations that are placed on you, and part of it is the opportunities that present themselves. I mean, if you want to be in a graduate program in many disciplines, you have to pay your own way. And that's…for some people, that's prohibitive. And, for example, lots of people who are married find that they can't get the family to survive on a teaching assistantship. So, you know, they may not be able to continue in their graduate studies because they can't fund it. So, all of that matters. Yeah.

Main Answers from Interview with Physics Professors (Question #4):

(4) What could be done to make the Mississippi education system better for producing highly skilled science and math students?

Professor #1: I think all the time we are trying to improve the situations in the schools. We have been trying to increase the facilities which are available in the schools. Most of the schools have, now, access to computers and also to internet. And so, I think these schools—my guess is, I have no first-hand experience in this—but my guess is that schools must have been improving over the last twenty years or so…definitely over the last twenty years, the schools must have been improving. So, the thing is, of course, to get more qualified, trained teachers who are really interested in bringing up the standards and interested in the students themselves, bringing up their standards. And, of course, in the states, it's taking…appreciating the efforts of these teachers so that the pay is such that these teachers can live with some dignity. And so, the two things go together, I mean, the teachers don't get paid well, then they cannot survive. Life is anyway hard in this school, and if the pay is also not good, then the teachers—good teachers—will not stay very long. So, both the things, I think: the teachers have to work, and the states have to take care of their teachers. And, I think…that things are happening, good things are happening, in both directions. That's what my reading seems to be…that the states are trying to increase the teachers' pays; and, more and more teachers are becoming aware that they have to really put in greater effort and greater dedication […] to their own work to improve the lot of the students.

Professor #2: That's a difficult question. I don't really know significant details about the "K through twelve" education in Mississippi. I know that physics education, in that range, tends to be weak across the state, although there are definitely some really good teachers in various schools. But, having a more qualified physics high school and middle school teachers would be good. I think students that are eight to ten years-old are often quite interested in physics; and, I don't know if we're doing a good job of engaging, uh, helping them explore physics at that age. I think it would be a good thing—eight to twelve to fifteen; pre-high school, I guess. And…but, I do think that a good physics teacher in high school would also help. Math-wise, to be able to do physics, you have to have math skills; and you need to be quite comfortable using math to do things, and so the more, the better.

Professor #3: Well, we're having some impact on it, and we'd like to have more impact on it. But, it's a question of…not too many of our high school teachers have a bachelor of science degree in physics or chemistry or biology…or a master's degree in any of those fields. So, I think it's a question of getting more people like that. Also, in our community colleges—getting people teaching the courses, you know, that have actually majored in these topics. And, we're having somewhat of an impact on that. Well, we sent…you took some courses here and went off and were teaching at community college…for example. So, I think that would have some impact. […] We can just about guarantee you that you will get a job—you know, a teaching job—but, you know, at a community college…or maybe a four-year college.

Professor #4: This probably starts at the high school level where students are given training in math and science. The math courses have to have sufficient complexity—not just memorization—to give them college math skills. And quite often, I think we're seeing that this is a bottleneck. A lot of the students coming in…maybe…are weak in math. And that's not going to help them out in any of the sciences, whether it's biology, chemistry, or physics. So, a student weak in math will have trouble going into any of these sciences, professionally. And so, my advice would be that students should take as much math as they could in high school. The second part of the answer would be that if a student wants to become an engineer, then he probably needs to take physics in high school, and quite often, this won't happen. Maybe the high school doesn't offer physics, or it offers it every other year. And so, I think if a student is really interested in engineering, he's got to somehow be able to take physics in high school. Quite often, chemistry and biology are emphasized, and physics is the third of the sciences that is maybe the most difficult. But, I think we have to place a little more emphasis on having all high school students, maybe, try to take physics. Now, that leads us, of course, to the problem of training high school teachers to teach physics.

Professor #5: Well, again, I'm less familiar with the details of the Mississippi education system. Perhaps putting a little more emphasis on…well, math, science, and other…even just other scholarly things, and less on this overweening emphasis on sports. I mean, the sheer amount of time spent by the students on sports compared to what they're spending in class—if you count, you know, going to games or whatever—and, the amount of effort that a teacher has to put into handling that. I know of one of the local high school teachers who seems to spend all their time—or a lot of their time—dealing with sports, and they don't have the free time otherwise, because they're always having to chaperone the students…if they're on the road, or whatever.

Professor #6: It's really hard for me to judge that. I'm not a native here. I didn't go to high school here. My children are not yet of high school age, so I haven't really seen…although the Oxford schools seem to be very good, very strong, and they produce national merit scholars and other things. I have been pleasantly surprised by some undergraduates that I've had from small places around Mississippi who're very strong and do very well. So, it's not always students from the places that are more affluent, where you might expect to have the better schools, that perform the best. I had a young kid from—a public educated kid—from some small town, who's a biochemistry major who just, you know, flourished in my introductory physics class. So, there are examples of that sprinkled all over the place.

Professor #7: Getting highly skilled math and science teachers…which is a problem, because…you're going to have to do it from the base up. The high school teachers tend to be…tend to come from football coaches, cheerleading coaches, and they say, "Oh, by the way, you're also going to teach chemistry and physics." And, they're completely just…they're not professional physics teachers, they're not professional math teachers. And, you do have some, but those who are truly qualified end up teaching at a junior college level or a collegiate level. And, you really need to get a broad pool of talent at a lower level to even begin. It may end up having to be that there aren't just enough people, and so […] there may have to rise up some type of distance learning program or self-paced learning, where you get an individual who does understand physics, but he can't go everywhere. So, the students have to go online to him, because there just…obviously, there's just not enough qualified teachers.

Professor #8: I mean, in a way it's not hard, because we know what to do; and in a way, it's hard, because nobody's going to do it. This is the problem. I mean, I just think…I really believe that it's […] a question of getting well-qualified teachers to teach in these schools. […] And, to get well-qualified teachers to teach in these schools, that means you've got to pay them some money. Not whatever they pay them now, which is not a lot. And, so nobody's going to suddenly double the salaries of teachers. That's not going to happen. And, then I think, also, you have to spend some money on…you know, laboratories, and things like that. And, I don't mean just computers, right? It seems to me every time people talk about spending money to improve schools, what they mean is: buy a bunch of computers. That doesn't do anything. I mean, you know, kids have computers at home all the time. So, I think […] if you get well-qualified teachers in the high schools, I think you can solve this problem very quickly. I mean, it might be generational; it might take like…you know…you have to like get a generation of students out. […] Talking to my students, you know, I've heard from several that…one guy told me the guy who was teaching his physics class was a basketball coach. So, it's not that the physics teacher was bad, it's […] he wasn't one, right? So…that's the problem. […] I think there's people who actually like teaching and probably would like to do it. But it's just like, "How am I going to live on this money?" Right? So, they just…they just don't. And, I think that's the problem.

Professor #9: I think you should again start at the beginning, I mean, start at the basics. So, I mean, you cannot wait for the kids to come to college to, you know, to work on their math and science. And, it should start from school, and before that, it should start from their home. […] It's not enough just to send your kids to school. You have to follow up at home. You know, you have to have an atmosphere. You cannot have…you know…on a weekday having a party outside and kids running around. I mean, you have to go sit home, and you have to make those rules, you know, "You have to go and study, because you're expected to do that." So, that's the first thing. So […] there has to, from first, from parent's side, there has to be an interest in education. Right? Even though the parent or the parents may not be well-educated, there should be an interest in education. That's very important for the kid. And then, you know, we have to improve the level of teaching in school. Right? I mean, I think our kids are smart enough. If you just give them the opportunity, give them the exposure, they will learn things.

Professor #10: I think that the educational system in Mississippi has to be improved, but has to be improved from "K" [kindergarten] [inaudible word/s] first, and then high schools, and the middle schools, high schools, and so on. I think that the educational system in Mississippi—it's not at a level to produce highly skilled science and math students in Mississippi. I don't want to put all the blame to the teachers. But, certainly the system does not work. There are very few teachers with science degrees, very few with physics degrees. If you have teachers who are not prepared, then they cannot prepare students. So, if you have a teacher that doesn't know anything about physics, they cannot teach the students physics; and, the students will never be interested. And, if you have teachers who are not well-prepared, who don't know the material; they cannot teach effectively. If you have curricula that do not put emphasis on science, you cannot produce students. So, I think that unfortunately […] I would overhaul completely the educational system in Mississippi. And, of course, there is also the cultural issues. So, we are not living in a society where science is valued […] in general, too much. But, I think the educational system would have to be better and more teachers. And, this also involves paying teachers more; because if a salary for a teacher is not comparable to a salary in another profession, the best people will not go to teach.

Professor #11: Well, I don't think there's any secret here. I think that…there…really, actually I think there are two important factors in that. And, one is getting high quality instructors into the high schools. And, you know, here in Oxford, and in Jackson, there are some very high quality instructors for math and science. But, you know, out in the rural areas, which is most of Mississippi, it's extremely difficult for them—for those school districts—to get physics teachers that are actually trained in physics. What they typically do will get somebody maybe that was trained in math, or trained in, you know, engineering maybe, or even something more far afield like computer science or something like that. And, because it's vaguely technical, they'll ask them to teach physics. Or, you know, even worse: nobody wants to teach physics, so the football coach or somebody just kind of gets stuck teaching physics. And so, that's a major issue, I think. But there's also a second issue which is the culture, the home life. I mean, you can get all the great instructors in the world into these positions, but if the students are not motivated to pursue these fields and take these courses, then they're not going to; and, even if they are, you know, they may not be either willing or motivated enough to put in the effort to be successful at them. So, that's another issue, I think—equally important, actually, [to] getting the good instructors in place is having a culture within the communities that supports these kinds of courses and pursuits…career pursuits. And, so anyway, I think those are the two main factors.

Professor #12: Well, based on my brief experience of [close acquaintances I know who have been] in high school, I don't think that enough is demanded of the students. […] Unless they're already motivated, and unless they say, "OK, I'm going to take four or five AP classes," there isn't the discipline, you know, to force them to use their mind, to force them to really exercise the intellect. And they may never discover that there's uplift and that there's inspiration in using your mind for serious scholarship. And, the other thing is, […] there does seem to be quite a bit of chaos in the classrooms…even in the better schools. The things that absolutely would not have been tolerated in my own elementary school are going on all the time, and same in the high school. […] There's a […] low buzz of other activity, of people minding their own business and holding their own conversations—over the lecture! I don't let that go on in my college classes, but the students do attempt to do that.

Main Answers from Interview with Physics Professors (Question #5):

(5) (a) When did you become interested in physics? (b) Did you take physics in high school?

[*Note: During the flow of the interview for this question, the interviewer neglected to directly ask part (b) of this question in most of the cases. However, in many cases, the professor more or less answered part (b) during the course of his or her full reply. Also, there were two cases in which the interviewer asked the Interview Question #5 in a way that was too different from the way it is shown above. Thus, the interviewer did not include those answers among these "main answers" for Interview Question #5. However, there was still much good information gained from such cases. One can observe the complete transcripts of the interviews to get the full context and wording of how the interviewer asked the various questions to each professor; one can also see the full reply of each professor.*]

Professor #1: I was actually still in high school when I got interested in physics. One main reason for that is that there was a very good professor in the college, and he used to give…he was very interested in the subject—gave very nice lectures—and even though we were in high school, we attended some of his lectures; and we liked those. And then, of course, when we came to big college then we attended his classes. And, he was a very inspiring teacher, and that really made the difference. The other thing was that my father had a nice library, and we had some nice books.

Professor #2: Pretty young; maybe back as young as twelve, or it might have been sooner, I don't know. I didn't know it was physics; it [was] just science about how things worked in the world that we live in. But, we did do some things in my pre-high school classes that were physics—even if it wasn't called physics—which I found especially interesting. I didn't take physics in high school, because I knew a physics professor that told me that the high school physics teacher in my school didn't really have any background in physics at all, and thought that it might be a mistake. So, I didn't. And, I didn't have any regrets about that. […] So, anyway, I would say it was pretty young for me—at least as young as twelve and maybe back younger than that…I don't remember very well. [*At this point in the interview, the interviewer questioned the professor a bit further about what age the professor was when the professor began to think about the possibility of actually pursuing a career in physics. The following few sentences are the main answers given by the professor in that part of the interview.*] Somewhere in my second year of college, I decided that I was better suited for physics than for some other things that I at least thought about doing. […] And I enjoyed it; but, there were a number of things that I enjoyed doing; but I decided eventually that some of those things that I enjoyed doing, I wasn't all that good at; so…so I should stick with something that I was better at, which was physics.

Professor #3: Oh, very early in life. I got a telescope, you know, very early in life—like in first grade—and started looking at the moon and Jupiter and things.

Professor #4: I grew up on a farm, and I always liked to watch my Dad work with the tractors and things. And, I guess I liked to work with my hands. And, I remember getting a chemistry set—maybe that's how a lot of scientists started—and setting it up on a little desk on the table (and probably doing some dangerous things). And then, luckily enough, in high school, we did have a physics course. And, I remember it was a bit more memorization than actually doing physics things, and maybe…I don't recall doing a lot of labs. But, at least I was happy that there was a course in physics offered, and I'm pretty sure that the chemistry teacher taught the physics course. But, anyway, I began to become very curious about things in physics, and I may have tried to understand things at the next level. I remember trying to do science fair projects, and I remember my dad helping me. And, when I went to college, I came close to being…I decided I was either going to be a geologist or a physicist. [*At this point, a brief pause occurred in the interview due to someone entering the room or maybe due to a cell phone buzzing or something of that nature.*] So, when I got to college, I applied to be a physics major. And it was very difficult, because there were students from other places that just seemed to know a lot more than I did, but somehow I persisted. And, eventually, I began working with somebody in the department in nuclear physics—he had a nuclear physics lab. And, I began working in his lab and doing things, and you know, I could excel at certain things. I liked lab work, and I think he realized that I was good at this. And so that's how it all got started. I eventually struggled a bit, but I got through my first-year courses and began to take more advanced courses. And, I guess it all blossomed—I worked very hard—and, then I got into graduate school, at some point, in physics.

Professor #5: If you called it "science in general," from a little kid…well, back before I even got into any public school, you know…kindergarten and that era, at some level. As far as calling it "physics," that would have been high school, because prior to that, they didn't have separate courses in physics. You got the physics in a general science, but you wouldn't have called it physics. And, yes, I did take physics in high school. [*At this point in the interview, the professor was questioned a bit further about the exact time period when the professor began to decide to actually pursue a career in physics. The following few sentences are the main answers given by the professor in that part of the interview.*] Well, when I first went into undergraduate, I was debating between physics and chemistry. And, for me, I just felt physics was a little more "cutting edge," shall we say, in the research. And, that was just my choice and my opinion of the two.

Professor #6: When I took my first physics course my sophomore year of college. I had had physics in high school; I enjoyed it, but I didn't find it particularly stimulating. At that point, it was mostly, you know, vector diagrams and other things. In college, I kind of bounced around my freshman year before I kind of landed my second semester in a mathematics program. And for that, I had to take a physics course, the science and engineering physics, and it just really clicked with me at that point. And, it wasn't long after that, that I decided to become a physics major. Really by the next semester, I had become a joint major in physics and math, and started to read popular books on physics…and just fired my imagination, and I was hooked.

Professor #7: I became interested in physics probably like…sophomore…freshman in high school…really enjoyed working with the computers at the time, and…science came at an early age, and physics came in at about early high school. And, I had a really good, really good chemistry/physics teacher. [*At this point in the interview, the professor was questioned about whether this was in college or high school.*] No, [this was] in high school. At first, I thought he was quite average, but the more that I look at my students and their high school chemistry teachers and physics teachers, I realize mine was actually quite good. [*At this point in the interview, the professor was questioned a bit further about whether or not it was during high school when the professor actually decided that physics was what the professor wanted to do. The following few sentences are the main answers given by the professor in that part of the interview.*] I thought that I wanted to pursue physics. Teaching physics didn't rise up until much later, until after I really graduated.

Professor #8: [*Note: During the interview with Professor #8, the interviewer asked Interview Question #5 in a way that was a bit too different from the way it is worded on the "Qualitative Survey Form (Interview with Physics Instructors)."* *Thus, that particular answer of Professor #8 was not included among these "main answers" for Interview Question #5.*]

Professor #9: I think when I was in grade ten, I think what really got me interested…I was reading some popular science books, and they were great. I mean, I learned a lot about physicists' work and how discoveries were made. And, I was very fascinated.

And, then I went to what is called “eleven” and “twelve”…high school. And, we had great teachers. […] I wanted to always…I was good in math, I wanted to, you know, carry on in math. And, really, the eleven and twelve, those teachers changed—I wanted to apply math to, you know, physics. So, instead of just doing research in pure math, I wanted to do, you know, just apply it, too. And, they were excellent teachers. So, you know, those teachers make a big difference. And I would say that, you know, those two years I changed…I wanted to do math, [then] I said, “No, I have to do physics, and that’s what I want to do.”

Professor #10: Oh, I became interested in physics and astronomy when I was very young. My dad gave me, for one Christmas—I think I was probably six or seven years-old, eight years-old—a small telescope; and then I got really interested in astronomy; and then, in order to do astronomy, you need to do physics. So, I became interested in physics—but, at a very early age. And so, this again relates to what I said before. At least in my case, there were two important factors. One was the cultural factor. So, the fact that my parents realized that science is something important, and so, they gave me the telescope. If you are living in a society where science is not valued, you cannot really get people interested. So, that’s a cultural factor. And, the second factor is that I was always helped, in pursuing science, from my teachers…in elementary school, first; in middle school, high school. It was a very good educational system where in high school I took many classes of physics—also high-level classes. And I always had the support of the science teachers and so on. So this is the second factor. There is a cultural factor and

[an] educational factor. And, I think that you need to have both [...] at least in my case, that was my personal case.

Professor #11: Well, I don't know that I can put a real specific date on that. You know, when I was a kid, I used to love to hook up string and pulley systems, and I'd have stuff strung up all over my room and hooked to my dresser and all that—you know, building simple machines and that kind of stuff. I had some interest in electronics, as well. And, you know, when I first went to college, I actually wanted to go into physical therapy or surgery, and so I was a pre-med. And I took my first—well, I took physics in high school and did well in that and enjoyed it, but didn't really think about it as a career. And, then I took my first physics course as part of my pre-med program as a freshman at the university (and, also along with all the other pre-med stuff you've got to do, like intro chemistry, and biology, and that kind of stuff). And, I just quickly figured out that physics was my favorite course that I was taking. And, so I started, you know—that's really when I decided that physics was the way to go. And, you know, even then, I still had in the back of my mind that—the university where I was, there was a health physics program or track within the physics department, and...and so that's kind of the direction I was still looking to go. But then as I got toward, you know, my upper level courses and stuff, I decided I really just enjoyed the pure physics, and then decided to pursue that.

Professor #12: [*Note: During the interview with Professor #12, the interviewer asked Interview Question #5 in a way that was a bit too different from the way it is worded on the "Qualitative Survey Form (Interview with Physics Instructors)*." *Thus, that* *particular answer of Professor #12 was not included among these "main answers" for Interview Question #5.*]

Main Answers from Interview with Physics Professors (Question #6):

(6) What were the important factors that allowed you to be successful in physics?

Professor #1: Well…I mean…that's hard to say. I mean, partly just luck. I guess you work, and you find that you are able to cope with whatever is required. And, it is not really guaranteed that you will be able to cope. I mean, you find out; you work hard, you take exams, and maybe if you are able to solve the problems, you will succeed. If you are not able to solve the problems, you are out of the system. And every time you feel that you are barely able to make it, you know, just go over the…over the bump. […] And just slowly learn a little more, learn a little more, and…and made it through. And so…yeah, I mean, it was…I never found things easy at any stage. I had to work, and I was never very confident that I definitely know this or something. Never made a hundred in any class or something like that.

Professor #2: Hmmm…that's a tough question. Self-examination is not so simple. Probably the most important thing was that I liked doing it. So, I was willing to spend time on it.

Professor #3: Well, one thing you have to realize is you have to study a little bit harder, you know, maybe than in some other fields. But, that if you do—and, maybe this could have been emphasized to me more when I was doing it—is: there really are a limited number of things that you have to learn. And, if you work ten, twenty percent harder, you can get about twice as good at them, with just a little bit of extra work.

Professor #4: Yeah, uh, these might be common attributes to a scientist. The first thing is curiosity…so there's blind curiosity about the world, always trying to discover new things. I think you have to also have a sense of not believing everything you're told. Your first reaction to dogma might be to think that, "Well, that might not be true in all cases, and maybe I should go and investigate." So, that would be a second trait. And, then the third trait has got to be just…just hard work. Sometimes I can't believe, you know, all the notebooks and homework problems and things you have to do to finish a class. I'm just astounded by…sometimes I look in my old notebooks and things, and I can't believe I even did all of this at some point. So, it's just curiosity, a sense of disbelief or wonderment about the world…and never taking anything as absolute fact, maybe…and then finally, the very hard work it takes to be a scientist. Those are the three most important things, I think.

Professor #5: Well, one is "sticking to it." In other words, just continuing to do the work and being willing to put the long hours, as needed. Plus, you know, having a good background, starting from my elementary school onward; I was lucky, they were pretty good. And, the colleges were good, as well.

Professor #6: Really, I think for me, it was just having a passion about the subject matter. I think people who go into physics, they're not doing it to be trained for a profession, generally. Most of them just really enjoy physics. And, so, I think my motivation was just I really found it fascinating. I was always a good student, so I always strived to do well in whatever courses I took. But, with physics, you know, that's where I wanted to be; and every little layer that would be uncovered to me, uh, I wanted to know more.

Professor #7: One: confidence, bordering on the level of arrogance. Because, to be in physics, you have to be very confident in what you do, and you can't show a room of a hundred students that you're teaching any form of weakness. […] In physics, it's like everybody tends to be arrogant or highly confident. And so, your physics ideas have to stand—and particularly in the research field—they have to stand their…those ideas have to stand their ground. And, you have to be prepared for people to attack you, because your ideas may be in conflict with others. And so, you have to be able to defend it. […] The second thing is just a tinge of…or just a small portion of insanity. That physics…you have to know…you have to embrace new ideas…you have to consider just these weird—who can understand a magnetic field? You can't see it, but you have to envision it. And, you have to manipulate things in it. And, a lot of people would consider that an insane thing. And, neither of which is actually knowing your material, but I think the arrogance and the insanity part are, I think, very important parts to being a good physicist…and good physics.

Professor #8: I really feel like one thing that was really important was: I had a pretty strong math background. So, in other words, instead of having to spend a bunch of time figuring out the mathematics to be able to study physics, "Well, OK, I knew that already." And so, all I had to concentrate on was the physics. Because…my impression of my students is: a lot of times the problems they have, it's not so much the understanding of physics concepts. Right? They just have a lot of problems dealing with the mathematics. So, they spend a bunch of time manipulating equations, and trying to do this, and trying to do that. And, they get lost in the forest, and they can't even see the trees, which is the physics. And, I think that's the problem. They have to spend too much time on stuff that really—I don't want to say they should know—but, if they knew it, it would make life much, much easier. So, I mean, I think that's really what helped me a lot, because I could spend time studying physics and not trying to figure out a bunch of mathematics.

Professor #9: One of the things is you need to have good training. Of course, the first thing is, you know, you should have an interest…you should really have an interest. So, if you are interested, then you feel like working, you know; it's not that "I have to work because this"…no…people are working all the time because it's not that they have to do this, [it's] because they like it. And so, the first thing is: get interested. Because, when you get interested, you just work. And, I think it's also important, no matter…I mean, you might have an interest; you are willing to work hard; but you need to have good trainers and good professors, good teachers. Those are very important, so I was kind of lucky to have them.

Professor #10: What are the factors that made me successful in physics? Well, one was, as I said, the educational system; and I always found very good teachers; and that they motivated me; and they also, they knew their jobs; they knew how to teach. And, the other factors, of course: one has to be motivated; you should not think too much about your career, or your salary, or when eventually you will get a position. So, more personal factors, essentially…more personal things play a factor. So, you have to start—it's like a race—you have to start well, and then…but you have to keep your speed, OK. So, you need some stamina—at least to keep in. Otherwise, you will not win. So, starting well is the cultural thing and the educational system; and then your stamina is up for yourself.

Professor #11: I think that it takes a lot of work. […] The material is not easy. It's not easy for anybody. I'm no raw genius, in terms of the mathematics and things like that; and so I had to work hard at learning that material. And, so, that's part of it, and really just—but, I think the real key bit is that you have to take pleasure in that work. If it's just work, then you're never going to succeed. Because, you know, you'll burn out. And, so at some point, there has to be this, you know, genuine satisfaction, enjoyment, of solving that problem, understanding that material, getting that program to work, getting the bugs worked out of an experiment, seeing that first data roll in after a year of building up an experiment. All these things are—you have to have a genuine sense of satisfaction through those milestones. And so that's the motivation that keeps you going through the next year of building up a new experiment or working on a new calculation. And so, those two things, I think: just a genuine enjoyment of the field and the work; and a willingness to put in the time and not—certainly not—think of the time versus money equivalence.

Professor #12: Umm…persistence, I guess. [That would be] one thing. But, I think with physics, you have to love it, because the work is too hard if you're not motivated. It's like climbing mountains, you know. If you're not motivated, it's not going to be any fun. You don't enjoy the views. So, that was part of it. And, I think I had the advantage of a very, very demanding elementary and secondary education. And because the demands were so high, I was really well-prepared to launch into physics as a major.

Main Answers from Interview with Physics Professors (Question #7):

(7) Does the physics profession represent a profession in which Mississippi students can realistically obtain a well-paying job with satisfying job conditions?

[*Note: During the flow of the interview for this question, there were some cases in which the interviewer asked the Interview Question #7 in a way that was too different from the way it is shown above. Thus, the interviewer did not include those particular answers (for those cases) among these "main answers" for Interview Question #7. However, there was still much good information gained from such cases. One can observe the complete transcripts of the interviews to get the full context and wording of how the* *interviewer asked the various questions to each professor; one can also see the full reply of each professor.*]

Professor #1: [*Note: During the interview with Professor #1, the interviewer asked Interview Question #7 in a way that was a bit too different from the way it is worded on the "Qualitative Survey Form (Interview with Physics Instructors)." Thus, the interviewer did not include that particular answer of Professor #1 among these "main answers" for Interview Question #7.*]

Professor #2: I guess I would say sort of what I said just a moment ago: if you really like doing it, then you'll enjoy your work. […] Now I like doing physics, so I like the job that I have. There are other physics jobs that are not teaching, that I'm sure are equally—or maybe even more rewarding than the one that I have. I think people ought to do what they like doing, as a profession, because they're going to do it all the time. And, if you don't like what you're doing, it seems like you've made a mistake.

Professor #3: [*Note: During the interview with Professor #3, the interviewer asked Interview Question #7 in a way that was a bit too different from the way it is worded on the "Qualitative Survey Form (Interview with Physics Instructors).*" *Thus, the interviewer did not include that particular answer of Professor #3 among these "main answers" for Interview Question #7.*]

Professor #4: Part of the answer is that every state has a different profile of businesses in the state, and unfortunately, Mississippi doesn't have a lot of what I would call "applied physics businesses" that are doing applied physics. And, I say "applied physics" because a lot of our…a lot of students you train should have some capability going out into getting a job in some field where they're applying their skills at the bachelor's level. If you want to do graduate work, maybe, you…I guess if you're trying to get your PhD […] you're going to be looking for a job, and it could take you anywhere. But, what I always think is that in every state there's…you know, if you're living in California, there's Silicon Valley…but, we just don't have something like that in every city in Mississippi—it's still a very rural state. So, uh, my hope is that when students come to get degrees in physics, that we train them, uh, we give them enough skills that they can go out and look for these applied physics jobs. Sometimes, engineering firms will hire physics students because physics students have a different way of solving and looking at problems. Engineers are trained in a very narrow approach. This inquisitiveness that physics students have often makes them approach a problem in a different way, and even sometimes give more creative solutions. So, I think most of the firms that I know about who hire scientists would probably hire a physicist or an engineer, equally, and so we just have to make sure our undergraduate physics students get good solid training in what I would call "applied physics areas".

Professor #5: Well, if nothing else, the training will do you well, no matter what other profession. I'm assuming we're talking about in science in general…though it certainly wouldn't hurt for journalists and others to know something about science, including physics. But...yeah, it's…you know, it's not that wide of a field, you know, there aren't hundreds and thousands of jobs in physics—certainly not in Mississippi. But, yes, you can get a good, well-paying job; or, you can apply what you learned in physics to a job in medicine, or chemistry, or biology, or engineering, or whatever.

Professor #6: [*Note: During the interview with Professor #6, the interviewer asked Interview Question #7 in a way that was a bit too different from the way it is worded on the "Qualitative Survey Form (Interview with Physics Instructors).*" *Thus, the interviewer did not include that particular answer of Professor #6 among these "main answers" for Interview Question #7.*]

Professor #7: It's always good to understand physics because to understand physics is to understand thinking. From what I understand, if you're a physicist…there were six applicants that went to med school, and all six got into med school in Jackson. So, to be a physicist […] you're hardcore when it comes to your academic abilities. […] I could live here professionally as a tutor. Any academic town…you could put your shingle up and say, "I am a professional physics tutor, slash math tutor, slash algebra tutor," and swarms of people would come, because…there is a distinct vacuum of qualified people teaching. It's OK not to be a professor here, you could just tutor. […] If you really knew how to teach and teach well and got a good reputation, you couldn't starve in this town. [*Note: Although during the interview with Professor #7, the interviewer asked Interview Question #7 in a slightly different way than it is worded on the "Qualitative Survey Form (Interview with Physics Instructors)," the interviewer still thinks the wording of his* *interview question was close enough in meaning to the one on the qualitative survey form. Thus, the interviewer included the answers of Professor #7 within this sample of "main answers" for Interview Question #7.*]

Professor #8: [*Note: During the interview with Professor #8, the interviewer asked Interview Question #7 in a way that was a bit too different from the way it is worded on the "Qualitative Survey Form (Interview with Physics Instructors)." Thus, the interviewer did not include that particular answer of Professor #8 among these "main answers" for Interview Question #7.*]

Professor #9: With a degree in physics, not only do you get a degree, uh…a job in which is physics, you can […] go to any other branch, whether it's medicine, whether it's computers. […] So, it's just that physics education makes it so much, uh…your thinking is so much more different […] that it helps you in any field. […] So you might take a degree in physics, then you might go and decide to go in medicine, or you might go in computer science, or finance. But, uh, the way that you are taught to think in physics is going to help you. I mean, so the thinking is very different. So, good students, like in India and China, are going to go into physics. Because, even though, um—a lot of my friends in undergraduate who were in physics: one of them is a big manager in Microsoft, one is doing something else, and someone has gone to medicine. But, as a good student, your default was to go to physics, because with a background in physics, you can pretty much do everything. And so, it's a very, very good investment to actually have a degree in physics. You can always branch up to anything, and the physics education will really,

really make you better than, on an average, better than the rest of the people. [*Note: Although during the interview with Professor #9, the interviewer asked Interview Question #7 in a slightly different way than it is worded on the "Qualitative Survey Form (Interview with Physics Instructors)," the interviewer still thinks the wording of his interview question was close enough in meaning to the one on the qualitative survey form. Thus, the interviewer included the answers of Professor #9 within this sample of "main answers" for Interview Question #7.*]

Professor #10: I would ask him or her a question: do you want to stay in Mississippi, or do you want to go somewhere else? Because, if a student wants to stay in Mississippi, then I don't think that person can get a well-paying job in physics, with satisfying job conditions and so on. I mean, yes, certainly you can, because there are always the exceptions, OK. But, overall, I would say probably no. But, if you are willing to go somewhere else for your career, or live somewhere else, and to other areas—yes, certainly…certainly yes.

Professor #11: As you may know, our largest group of undergraduate physics majors are pre-meds. And, one of their main motivations is getting into medical school. And, we have an extremely high acceptance rate in our pre-med program—"ours" meaning "the physics department." It's in the high ninety-percent range. And so…and I bring that up as an example because there—an undergraduate degree in physics does prepare you for a lot of technical fields—and there's a lot of, you know, both professional programs and other graduate programs that love to get undergraduate physics majors because they have been trained well in how to solve problems and to understand that the solution to a problem is not necessarily going to come in half-an-hour of thinking and working, but it may take hours and hours, or days and days, or weeks and weeks. And…so they have both the analytical tools and the understanding of the process, the problem solving process, that makes them well-suited for a lot of different technical fields. So, there's a lot of opportunities for [an] undergraduate physics major other than pursuing a career in physics proper.

Professor #12: Well, I think it's almost a foregone conclusion that physicists will find jobs, but they don't always find them in physics. […] But there's a broad range of industries that are hiring physicists. Academic work is open. There are jobs. And, I think—I don't know how it is exactly now, but I would say ten years ago, the American Institute of Physics showed results of what…the earning power of people when they got out of a physics program as compared to when they got out of chemical engineering or civil [engineering] or whatever. And, you know, the physicists sort of came "in the pack"—lower than chemical engineers, but above some others. [*Note: Although during the interview with Professor #12, the interviewer asked Interview Question #7 in a slightly different way than it is worded on the "Qualitative Survey Form (Interview with Physics Instructors)," the interviewer still thinks the wording of his interview question was close enough in meaning to the one on the qualitative survey form. Thus, the interviewer included the answers of Professor #12 within this sample of "main answers" for Interview Question #7*.]

Commonly Mentioned Themes from the Main Answers of the 12 Physics Professors who were Interviewed

Table 370

Commonly Mentioned Themes from Interview with 12 Physics Professors from the University of Mississippi

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1. In your opinion, are Mississippi students as well-prepared for graduate-level physics courses as students from other places?

**Yes.(3)

**No.(7)

**It is difficult to gauge; it is hard to know for sure.(6)

**There are some Mississippi graduate students who seem to be reasonably well-prepared; there are some Mississippi graduate students who do well.(5)

**We do not have very many students from Mississippi in the graduate program for physics.(2)

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2. (a) In general, how do American students compare with international students, in your opinion?

**In general, the international students who come here are generally better students than the American students.(5)

**The international students are not necessarily better students than the American students.(5)

**International students are generally better at the theoretical work, whereas the American students are generally better in laboratory situations.(2)

**International students have a better level of academic preparation for physics.(4)

**Although the international students who come here generally perform better, some American students have done very well.(2)

**International students sometimes have strong scores on certain standardized tests.(2)

**International students have a more rigorous math background.(2)

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2. (b) If there is a difference, what are the reasons for these differences?[a]

**The international students who come here are some of the better international students, because they have already gone through a selection process before coming here to go to school; so we are comparing American students with some of the best international students.(6)

**No differences were mentioned by the professor.(1)

**One factor which might be important in the relatively strong performance of the international students who come here is that they probably receive a more rigorous academic preparation for physics during their earlier years of schooling which helps them with their physics performance.(3)

**International students have taken a more rigorous math curriculum before they get here, and this is probably a factor that helps them with their physics performance.(2)

**In general, international students have to be good to be able to leave their country to attend college in the United states.(2)

**For many international students, it is very expensive to attend college in the United States; this can be another factor that selects out high-performing international students who are good enough to earn scholarships or otherwise afford to attend school in the United States.(2)

3. (a) Do economic factors play a large part in students choosing to pursue (or not to pursue) graduate studies in physics?

**Yes. (4)

**No. (2)

**Economics is a secondary factor in choosing to do graduate studies in physics. (3)

**Students choose physics mainly because they like it; they have a passion for the subject.(2)

**Physics is not particularly economically attractive, in terms of job salaries.(5)

**At the University of Mississippi, there is an unusually high level of economic support for physics due to scholarships and teaching assistantships which greatly reduce the financial burden on students.(2)

**In the graduate program for physics, it is possible to financially support yourself with an assistantship while you work your way through graduate school.(2)

**Physics requires much difficult work for not as much money as some other fields; this could be an economic factor that works against someone choosing physics as a major.(2)

**The salaries of physicists, though not extremely large, are decent.(2)

**Students who come from areas that are poorer or have less resources often face educational disadvantages which can sometimes negatively affect their background training.(2)

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3. (b) Do these [economic] factors differ significantly from country to country?[b]

**Yes, when various countries are compared, one can find variations in some of the economic factors.(2)

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4. What could be done to make the Mississippi education system better for producing highly skilled science and math students?

**Increase the number of highly qualified teachers.(8)

**Increase the amount and quality of math courses that students take.(2)

**Increase the number of highly qualified high school physics teachers.(7)

**I am not extremely familiar with the Mississippi education system.(3)

**Increase the number of highly qualified math teachers.(1)

**Make sure that we pay our teachers decent salaries.(3)

**Improve the level of teaching in school by the teachers who are there.(5)

**Put more focus on the cultural factors in the community and at home which cause students to more highly value science and academic pursuits.(4)

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5. (a) When did you become interested in physics?

**When I was in high school, I became interested in physics.(5)

**I had a very good teacher/s; an inspiring teacher.(4)

**When I was young (roughly 12 years old or younger), I became interested in physics.(3)

**In college, I became more serious about physics as a career.(5)

**In high school, I became more serious about physics as a career.(2)

**As a child or at an early age, I became interested in science in general, and then in high school, I became interested in physics, more particularly.(2)

**In college, I first became really interested in physics.(2)

**Reading popular science books or other nice books was an important component in my decision to pursue physics.(3)

**When I was young, I was given a telescope, and this helped me become interested in astronomy and physics.(2)

**My parents' (or a parent's) interest in science was an important factor in the fact that I became interested in physics.(2)

5. (b) Did you take physics in high school?[c]

**No(1)

**Yes(7)

6. What were the important factors that allowed you to be successful in physics?

**One must be willing to work hard.(6)

**One must show persistence; one must persevere through the difficulties.(4)

**I enjoyed the subject; I had a passion for the subject.(5)

**I was willing to spend time on the subject.(3)

**I had a strong sense of curiosity about the world or about physics.(2)

**I had a good academic background; I had good academic training.(5)

**One cannot think too much about salaries; one cannot think too much about the time versus money equivalence.(2)

7. Does the physics profession represent a profession in which Mississippi students can realistically obtain a well-paying job with satisfying job conditions?[d]

**The physics profession represents a profession in which Mississippi students can realistically obtain a good, well-paying job.(3)

**In Mississippi, there are not as many jobs in physics as there might be in many other places.(3)

**The training that you get with a physics major will help you in many other jobs or fields of study.(6)

**Majoring in physics will give you a very good chance of getting into medical school.(2)

**Studying and understanding physics will help you gain better thinking skills.(4)

[a]The researcher did not ask the question for part 2(b) to every professor during the course of the interview. However, in some of these cases, part 2(b) was answered by some of the comments the professor made in response to the question for part 2(a). One can look at the full interview transcript if one wants to see the specific wording of each question which was asked to each respective professor.
[b]The researcher did not ask the Question 3(b) to every professor during the course of the interview. Also, not every professor who was asked Question 3(b) specifically addressed it in the course of their answer for Questions 3(a) and 3(b). This was probably due to the fact that the question was a "two-part question," which could have added a bit of confusion as to which part to answer. One can look at the full interview

transcript if one wants to see the specific wording of each question which was asked to each respective professor and how each professor answered it.

[c]During the course of the interview, the researcher (P. Rogers) did not directly ask part 5(b) to very many of the 12 physicists, but many of them answered it anyway during the course of the interview. One can look at the full interview transcript if one wants to see the specific wording of each question which was asked to each respective professor and how each professor answered it.

[d]During the course of the interview, the researcher sometimes asked this question in rather varied ways which were not always the exact, same wording as the question given above. One can see the transcripts for more details about the precise wording the researcher (P. Rogers) used in each case.

Transcripts of Interviews with 5 Successful Mississippi-Native Physicists

The researcher interviewed five native Mississippians who were successful in obtaining careers as physicists in the state of Mississippi. The five physicists who were interviewed were either presently working or had formerly worked as physics professors or research physicists at universities in the state of Mississippi. The three universities represented by these five native-Mississippian physicists are the University of Mississippi, Mississippi State University, and the University of Southern Mississippi. The native-Mississippian physicists were all born in Mississippi, except for one case—and in that case, the professor moved to Mississippi as an infant. They also attended high school and undergraduate college/university in Mississippi.

Interview with a Native Mississippian Physicist, Labeled here as Professor #13, (July 2013 at a University in the State of Mississippi)

Paul: Why did you choose to pursue a career in physics?

Professor #13: Well, I don't have a real clear answer to that. I started out in engineering, in pre-engineering in community college; and, at some point, I decided I didn't want to do that anymore, and I picked physics. But, it could just as easily have been chemistry.

Paul: Yes sir.

Professor #13: I really don't—I never was clear on why I picked physics instead of chemistry.

Paul: So it was almost like…

Professor #13: So it was kind of a toss up.

Paul: OK.

Professor #13: And, uh…I picked physics, and [I've] been pleased with it since.

Paul: Well, was there a certain reason that engineering—that physics appealed to you more than engineering at that time? Like, what…what may have been at least some of the factors for that?

Professor #13: Umm…I think it was rather trivial reasons, at the time I first decided. Like, some of the required courses that engineers took didn't appeal to me as much as some of the ones physicists took.

Paul: Yeah.

Professor #13: They had a slightly different curriculum. But, there was not a real strong reason, initially.

Paul: Yes sir.

Professor #13: I always liked physics. We didn't really have a physics teacher in high school, but I read physics stuff and did a term paper on physics stuff. So, I was always interested in it.

Paul: OK. Well, was there, like, in your family, did you have a father or a mother that was in some field related to that?

Professor #13: No. I'm the first person to go to college.

Paul: OK. Well, what was it that got you interested in science as a younger—or, you said that you were sort of always interested in it—what do you think it was? Just…

Professor #13: Yeah, I don't know. I always liked to take things apart and figure out how they worked…

Paul: Yes sir.

Professor #13: …and I'm sure a lot of people have that story.

Paul: Yes sir. [chuckling]

Professor #13: So…I always liked to figure out how things worked.

Paul: OK. Well, what obstacles did you have to overcome during your years as a student and during your years as a physicist?

Professor #13: Really, I don't think I had any obstacles.

Paul: So, like…you felt very well-prepared in your academics at Vanderbilt, and…?

Professor #13: Yeah. I was very well-prepared at Mississippi State to go to Vanderbilt.

Paul: Yes sir.

Professor #13: Better prepared than most of my classmates were.

Paul: Hmm.

Professor #13: Most of the Vanderbilt students came from small schools someplace…

Paul: Yes sir.

Professor #13: …from all over the country. But, very few of them came from Ivy League schools or schools you would think of as being superior to us in some ways. So, I was as well-prepared as any of them.

Paul: OK. Well, whenever you got to college at Mississippi State, did you feel well-prepared from your high school years? Did you have, like, a really good math background or something like that? Or, how did you do that?

Professor #13: Well, I think I got a real good math background at community college. I think it was to my advantage that I went to community college, first. I had really good math teachers in community college. And, I don't know how I would have done if I'd started here. I think I'd have made it, but…I think I was very well-prepared.

Paul: OK. Well, do you think that Mississippi students are as well-prepared as other students for the academic rigors of physics?

Professor #13: Well, I think it varies greatly from one school to another. And, there's some very good schools in Mississippi, and people come out of them very well-prepared. But, of course, there are very poor schools in Mississippi where very few students come out well-prepared for a college physics course.

Paul: Yes sir.

Professor #13: So…it varies a lot. I could name two or three schools that the students are usually well-prepared from, MSMS [Mississippi School for Mathematics and Science] being the obvious one. But…

Paul: Yes sir.

Professor #13: But then there are a lot of really weak schools in Mississippi where the people from those schools are probably not going to have a chance…[or] most of them are not going to have a chance.

Paul: Yes sir.

Professor #13: I think we probably have more weak schools than most states.

Paul: Well, do economic factors play a large part in students choosing to pursue or not to pursue graduate studies in physics?

Professor #13: I don't think so. Umm, I mean, my first guess would be: no. I think most physicists probably came from poor backgrounds, or…a lot of them are farm kids.

Paul: Yes sir.

Professor #13: And so…I don't see any economic connection.

Paul: Yes sir. Well, one of the things—and this is sort of a slightly different angle than sort of the angle…like, as you had mentioned, you were thinking about the student from where he came from…and what about, this is sort of a different angle, what about the student looking at future job prospects? In other words, do you still see that as not being much of a factor? In other words, I guess what I'm talking about is: one of the things I've noticed about my fellow Mississippians is: there's many, many students that go into engineering. Or even the medical field, like, it seems like the medical field pulls our talent—but very few go into the queen of sciences, which is physics.

Professor #13: Yeah. I've noticed that, too. And I think, uh, it's a combination of wanting to make a good living…soon…

Paul: Yes sir.

Professor #13: …and not wanting to do a subject that most people find [to be] pretty hard.

Paul: Yes sir.

Professor #13: I mean, I was lucky. I found it [to be] pretty easy, until I got to some really upper level stuff. So, uh, I think there's not…there's not a love of learning among current students, even the good ones. I think we have a somewhat pampered society—even in Mississippi—where people get rewarded for rather mediocre achievements. And then, when something is really hard to achieve, they give up too quick.

Paul: Yes sir. Well, what were the key factors, in your opinion, to your success in physics?

Professor #13: Well, I always worked hard was one thing. But I, you know, I wouldn't consider myself successful as a physicist. I was successful as a physics teacher, I think.

Paul: Yes sir.

Professor #13: But physics is a very humbling field. And, there are so many levels of ability. I mean, I had a high enough level to be a university teacher. But, I've never had any great research accomplishment. And even the people that have strong research résumés are a great level below the really star physicists. And even those people are way below the people whose names go down in history. So it's…

Paul: Yep.

Professor #13: …it's a very frustrating field, in a sense, because you can work your hardest, and be pretty smart, and still not have the big idea…

Paul: Yes sir.

Professor #13: …or the big accomplishment.

Paul: Well, that's—I guess it takes all…

Professor #13: Right.

Paul: …and without good teachers—I mean, that's sort of my field—without good teachers, it's difficult to learn. [laughing] Well, what could be done to make the Mississippi education system better for producing physics students who will be in a position to have a successful career in physics?

Professor #13: Well, I don’t know how to do it, but I’ve always felt the key was having strong mathematics in the high schools. I always felt like I could teach somebody the physics if they could do the math.

Paul: Um hmm.

Professor #13: But, so many Mississippi students are so poorly prepared in math. Even if they made straight A’s in high school, they still can’t do fairly simple stuff…because, the standards are so low. So, one thing is: the math level needs to be greatly improved, and to…to jump on your field, the math education departments…

Paul: Yes sir.

Professor #13: …are…well, they just have very low standards.

Paul: Yes sir.

Professor #13: They don’t produce mathematicians, and they…they produce people who use fad methods…

Paul: Yes sir.

Professor #13: …and don't really, necessarily—the teachers, themselves, don't have a real good understanding of the subject. That's my impression.

Paul: Yes sir. Well, I think you're right in the sense that…that I've always felt that—I mean, I…like, I actually went into physics for my master's, just pure physics. So, I've seen both fields. And, I think that education—I think that a pure physicist will always, generally, have a leg up [i.e. an advantage] when it comes to being a good teacher. Because, the most important thing, I've always felt—and you can agree or disagree…I mean, you can tell me how you feel about it—but, am I right that: you've got to first know the subject? Is that right? [laughing]

Professor #13: Yeah. You've got to know the subject. Now, there are some smart guys that are lousy teachers, but there are no dumb guys that are good teachers.

Paul: That's a good way to put it. That's what I was trying to say! [laughing] That's a good way to put it. Well…do you have anything…any other comments or anything about physics in Mississippi that you would like to say?

Professor #13: No, I don't have any clear solutions to anything. We've always been fighting the battle that the math level in high school wasn't quite good enough.

Paul: Yes sir.

Professor #13: And now, we have the added problem that the literacy in high school is worse than it used to be back in my day. We used to know how to write.

Paul: Yes sir.

Professor #13: Most high school students don't know how to write, now.

Paul: Yes sir.

Professor #13: So, I'm a little pessimistic about that. But we, you know, we have bright students every year. And like you say, most of them do choose the instant gratification of engineering or computer science instead of the long haul of…a graduate degree in anything.

Paul: Yes sir.

Professor #13: I think that's why we're going to have foreign-born professors for the foreseeable future.

Paul: Yes sir.

Professor #13: It's not [that] universities seek out foreign-born people, it's just that they have a—in most of the countries that they come from, there is a respect for learning that we've lost…in this country.

Paul: And that's one thing that I can agree with you—at least, it seems to me—and that's one thing that I, hopefully, I'm trying to do my one little part to sort of revive that, or figure out how we can revive that. But, I thank you for the help, and unless if you have any further questions or comments, I guess that concludes…

Professor #13: No…I can't think of anything. I wish I had a clearer idea of how to improve the situation.

Paul: Well, the information—all of this information will be good information for the future, so…I thank you for your help.

Professor #13: OK. You're welcome.

Interview with a Native Mississippian Physicist, Labeled here as Professor #14, (July 2013 at a University in the State of Mississippi)

Paul: My name is Paul Rogers, and I'm doing an interview with [a physics professor from Mississippi]; and, this interview is about Mississippi physicists. And, the first question that I would like to ask is, why did you choose to pursue a career in physics?

Professor #14: Well, there are really two branches here. My father was a geophysicist, and so he was always interested in sciences and teaching us about science. And then, in high school, at…our physics teacher in high school was a physics grad student from [the nearby college]. And, he did a good job teaching, and made it interesting. And so, I did physics as an undergrad degree; and looked at math a couple of times there, but ended up getting the degree in physics.

Paul: OK. Well, what obstacles did you have to overcome during your years as a student and during your years as a physicist?

Professor #14: Umm…[laughing]…just like the good teacher was inspiring, in college we got a young visiting professor who…um…[was] teaching quantum mechanics, and this professor—the books weren't in—and so he lectured on the math involved with quantum mechanics. So, we got the math books about two weeks before the exam, and—we got the physics text—and I studied all the math, and the test was all on what was in the physics book, and I didn't do very well on that. And, that was pretty discouraging.

But, I bounced back from that. And, it sort of affected what sort of grad school I could go to.

Paul: Yep.

Professor #14: Then, I went to Ole Miss because they accepted me. [laughing softly]

Paul: Yeah. [laughing softly] Well, do you think that Mississippi students are as well-prepared as other students for the academic rigors of physics?

Professor #14: There are—from the ones that I teach, um…you know, we've got a lot of rural areas where the students are not well-prepared; we've got some excellent high schools throughout the state that do a good job of preparing students. But, you know, there are just places that don't have…well, they're just not as well-prepared, so…. Ole Miss has been doing good at attracting a lot of the well-prepared students, and so, things are better. But, uh, you know, it's something that would be nice to see the state improve. But, I don't know how you do it.

Paul: Yep. Well, do economic factors play a large part in students choosing to pursue or not to pursue graduate studies in physics?

Professor #14: I think so. You know, physics—at least at present—is a well-supported field. And so, if you go into graduate studies in physics, you'll get a good assistantship—

at least, a living wage. And, so I think that this does attract more people into physics. The engineering school here—the assistantships are only about a third of what they are in physics—and so, the students have to work other jobs and things. So, um, and you know, it's also reasonably…you're reasonably assured of getting a job…not as good as…it's that balance…that if you can get a job in physics…your likelihood of getting a job is pretty good because there aren't many majors. Not as good as engineering, those people are actively pursued for jobs and get larger salaries at the start. But, I think those two things are encouraging for attracting people into physics.

Paul: Yep. Well, what were the key factors, in your opinion, to your success in physics?

Professor #14: I have to give credit to my high school math teacher. [She] taught advanced math class. And, that really gave me the background to deal with the mathematics; and [it] made my math classes easier in college that she covered a lot of the college curriculum. So that's a big factor. And then…I don't know, doing…there were things I got through with my undergraduate degree, and sort of my graduate degree, and…at Ole Miss at the time, the work load wasn't too onerous that we taught—I think, two laboratories—and so, you sort of say, "I've got all this time, I'm going to learn physics very well." And so, that was a—that I had the time to really study and learn physics and not just try to get a grade in the class. And so, those two things, I'd say, would be the key factors.

Paul: Yep. Well, what could be done to make the Mississippi education system better for producing physics students who will be in a position to have a successful career in physics?

Professor #14: Um, you know, I think—well, reaching back to my own high school years—I think the really important thing is that math class, and the fact that there was a two-level math class [at my high school] where there was a…there were about thirty (out of a hundred and twenty people in my class) in the advanced class. And…so, we did a lot more than we would have otherwise. And, so, I think that maybe having advanced classes in math or…would really help. I don't think the physics background is so important as much as the math background.

Paul: Yep. Well, I thank you for helping me with this survey.

Professor #14: Um hmm.

Paul: And, is there anything else about physics and Mississippi physics that you would like to mention, that you can think of?

Professor #14: No, not really. I think your questionnaire was pretty good about covering the ideas.

Paul: OK, well, I thank you for helping me today, and I guess that concludes our interview.

Professor #14: Alright. Great.

Paul: Thank you.

Professor #14: You're welcome.

Interview with a Native Mississippian Physicist, Labeled here as Professor #15, (July 2013 at a University in the State of Mississippi)

Paul: Well, today, I'm interviewing a professor from Mississippi State University. And, the first question that I would like to ask [is]: why did you choose to pursue a career in physics?

Professor #15: Well, I grew up out in the country from Mississippi State, out at a [small community]. Went through the eighth grade there. Had good teachers, as a matter of fact. But, the population down there was so small that they closed the high school. And, we had three grades in a room. For the last six years, I had two teachers. And, they were quite good. And, then I transferred up to [the nearby city high school] which was an excellent school at that time, and I think it probably still is. Had a good…I mean, if I had stayed out in the county system, I wouldn't have gotten, you know, mathematics and science education. But there, I got good courses. I had trig [trigonometry], and I had algebra and some advanced courses in mathematics. I had chemistry. I had physics. I had a good physics teacher. And, I'd always been interested in things. I remember when I was a kid, we had a front porch that was about three feet off the ground, and I got so interested in watching an airplane that I just walked off. [laughing softly]

Paul: [laughing softly]

Professor #15: So, I'd always been interested in things like that.

Paul: Yeah.

Professor #15: And, I was used to working hard. And, I did well in [the nearby city high school]. And, you know, physics had the reputation of being tough. So, I think it was kind of a challenge. That's one thing that got me to do it. I enjoyed the stuff, and I could see, you know, that there was a lot going on in the world. And, I thought it was kind of a challenge. I just wanted to try it. So, I came out here. And, I had several good teachers out here at MSU.

Paul: Well, like, what was it, do you think, that sort of led you down the physics route instead of the engineering route? Was it luck? Or maybe, did you sort of luck into it or you actually consciously, you know, chose that?

Professor #15: Well, I think I wanted more in-depth about what was going on in the physical world rather than applying it, at the time.

Paul: Yeah.

Professor #15: I sometimes look back and think, “Well, maybe I should’ve gone into engineering.” But, at the time, I wanted to look at the physical sciences more in-depth rather than taking a small part of it and applying it.

Paul: Yep. Was there…do you think [there] may have been like some teacher [who] sort of encouraged you, and sort of built you up, in the sense that helped you sort of feel confident in it? Or maybe it was just your natural ability…as far as…your natural interest in the subject, basically, that….

Professor #15: Well, I think most of it was probably natural interest, although I did have some good teachers. And…but, I think it’s mainly natural interest.

Paul: OK. Well, what obstacles did you have to overcome during your years as a student and during your years as a physicist?

Professor #15: Well, one of them was, you know, I was the first person in my family to go to college. And, we were not well-off. And, uh, I remember when I first started, I was working part-time as a clerk at JC Penney, you know. But, I got out here and got involved. I started in the summer. Finished in three years, which I really don't recommend; because by the time I'd finished, I'd done OK—in fact, I'd done very well—but I was kind of tired when I went to graduate school. But, I was doing that, and then I got so busy studying physics and chemistry and stuff like that, that I had to quit working there. And then, uh…you know, it probably put a—I didn't think about it at the time—but, it probably kind of put a burden on my father supporting me, even though tuition and things were much lower then (but, salaries were, as well).

Paul: Yes sir.

Professor #15: So, uh, that was one of the things. And then, uh, I didn't know where to go to graduate school. I looked around at Ole Miss and LSU and Alabama and Vanderbilt. And, Dr. Howell had a master's degree from Vanderbilt, and he encouraged people to go up there. And, I think it was a very good choice. One of the good things that came along—you know, I finished in [the 1950s], and if you recall, the Sputnik was put up in 1957. So people got real interested in people pursuing physics, you know. And, they put more money into helping graduate students. And, that was a big plus.

Paul: That's what I'd heard—from someone else—that during that time period, there was a lot of interest, a lot of…sort of a push towards physics for…

Professor #15: Right. And, in fact, after my first year at Vanderbilt, I got a job down at Huntsville working for the Army Rocket and Guided Missile Agency, because NASA hadn't been formed at that time, obviously. And, it was kind of interesting, because they put me to doing nuclear spectroscopy, you know, which was studying the radiation coming from some radioactive materials. And, I don't remember, exactly why they thought that would be relevant to a missile program, you know. Maybe they were looking ahead to space exploration, you know, and the fact that the astronauts would be radiated in space, I don't know. But, anyway, that was interesting. And, uh, then when I got back to Vanderbilt, they had just hired, uh—I don't know if you've ever heard of him or not—Joe Hamilton, who is a well-known nuclear physicist now.

Paul: A few people mentioned him…as being sort of a famous…

Professor #15: Yeah. They'd just hired him. And, the department head called me and said, "Well, I see you did some nuclear work down at Huntsville, and we've got a new guy, and if you'll go to work for him, we'll give you an assistantship," which was a big break. I mean, uh, my…I mean, I would look at my bank account sometimes, and I would be into double digits…my bank balance. [laughing]

Paul: Yeah. [laughing] Enough to make you sweat.

Professor #15: Uh, I didn't have it particularly easy, but working with Hamilton was good. And, then, he had contacts, of course, at various places. So, I got…when I finally graduated in nuclear physics, Dr. Howell—you know, back in those days, Mississippi State was not integrated; it didn't have a very good reputation, you know, internationally (or nationally, even). And, it was hard to hire people, you know. And so, he…that's the reason he hired…he hired me, of course, he hired Dr. Crow (who was a graduate here), and he hired Dr. Ferguson (who was a graduate here), and various others. And so, I came here. And then, uh, my contacts—through Howell at Oak Ridge and through Dr. Hamilton—I got summer jobs at Oak Ridge several times. And, uh, that was a big help. And then, I got a sabbatical out at Savannah River Laboratory, which was kind of interesting. It's in South Carolina. I don't know if you remembered that or not.

Paul: No sir.

Professor #15: One thing that kind of intrigued me at the time—and I wondered why they did it this way—but, I mean, I went to a motel there in Aiken, South Carolina, I believe it was. It was either Aiken or Savannah, Georgia—I don't remember which—but they're both fairly close to Savannah River Lab. And, in that motel, they had a map, you know, showing the area; and it had an arrow saying, "To H-Bomb Plant." [laughing softly]

Paul: Oh…that'd… [laughing softly]

Professor #15: You would think they would be trying to keep the existence of the H-bomb plant away from any potential enemies.

Paul: Yeah.

Professor #15: But, uh, I thought that was kind of interesting.

Paul: It may have been like a fake or something. [laughing] Who knows? [laughing].

Professor #15: Yeah, so, uh…and, uh, then I had a few graduate students. In fact, I had a letter from a graduate student the other day that had done a master's degree with me here.

Paul: Yes sir.

Professor #15: And, he's already retired over at Huntsville. In fact…and, I had another interesting experience. One of the classmates I had here at MSU eventually took a job at NASA and got very involved in the space program, as did this student of mine. And, both of them are retired. But, the guy who is my classmate got me a pass to go watch Apollo Eleven blast off. You know, and we just had the forty-fourth anniversary of the Apollo Eleven launch, and that was really spectacular. That inspired me even more.

Paul: Yeah.

Professor #15: And then, a little bit later…a few years later, I had worked for that former student a couple of summers over at Huntsville, and he got me a pass to go down and watch one of the shuttle launches, which was also very impressive, so…

Paul: Hmm. Well, it seems like, from what you and others have said, the space program was a big…a big, I guess, engine for physicists.

Professor #15: Yeah. The nuclear program and the space program, back in those years—because we were competing with the Russians—was a great help to students. And, I don't think students today have quite that advantage.

Paul: Well…so, you got your B.S. at Mississippi State and your doctorate at Vanderbilt, and I guess…did you get a master's [degree], too? Or, [did you go] straight for the doctorate?

Professor #15: Well, I was planning to get a master's degree, but some of the work didn't pan out like my director thought it should, you know…

Paul: Yes sir.

Professor #15: …so I just skipped it and went on and got the doctorate. [laughing]

Paul: Just got the doctorate. Well, that's…that's good. I was just…

Professor #15: I don't necessarily recommend that; but I mean, that's the way it worked out best for me, I think.

Paul: Yeah. I was just making sure that I understood exactly where, you know, where you had gone. Well, do you think that Mississippi students are as well-prepared as other students for the academic rigors of physics?

Professor #15: That's hard to say, because I don't have experience teaching students from many other places. We have a few students come in from Alabama and Tennessee and some of the local places, but…

Paul: Yes sir.

Professor #15: Umm…one thing I noticed—and this is not answering your question—but I noticed that over the years, students got where they didn't want to work as hard as they did when I first started teaching…

Paul: Is that right?

Professor #15: …and that disturbed me, because I think it's in the national interest, you know, that we do produce a lot of our own PhD physicists rather than having to get people from India and China and various other places to come in here. But, uh …

Paul: You noticed …

Professor #15: …I don't think … I don't think our students are prepared as well as they should be, but it's difficult for me to say whether they're prepared as well as the average student throughout the country—but I doubt it.

Paul: OK. Well, during your years as a teacher, did you notice a change as far as the number of international students? The impression that I get, just from talking with others about college in general, is that at one time there was…it was mostly native Mississippi students…

Professor #15: Yes. You're right.

Paul: … or maybe native American—native…you know, native…not native American as far as Indian (what we call "Indians"), but Americans.

Professor #15: Yes. You're right, that…

Paul: But it changed.

Professor #15: It changed dramatically.

Paul: Yes sir.

Professor #15: And today—I don't know what the numbers are because I don't keep up with it—but today, probably most those graduate students here are foreign students, would be my guess.

Paul: Yes sir. That's what I had noticed in…in…

Professor #15: Oh, yeah, that's…that's bad news, in my opinion.

Paul: Yes sir. I mean, like I…I think that it's…it definitely is worrisome if you…if you…at least we should have—like you had said before—at least we should have some. That's sort of one of the reasons that I was interested in this study. It seems that we should at least be producing some, anyway. [laughing]

Professor #15: Oh, gosh yes. And, one reason they don't: I don't think people in power realize, you know, that we ought to be doing that…

Paul: Yes sir.

Professor #15: …better than we're doing it now. I'm glad you're doing this study.

Paul: Yes sir. And, I noticed…I also noticed that it seems that the higher the science, the more it is like that. It's almost like it's farmed out…to…. In other words, if you go to, let's say, business or accounting or even history, you find mostly people from America. And then, as you go into engineering, maybe it gets more…there's a lot more international. But it seems, as you get into physics—and maybe that's just my impression, I don't know if you got the same impression over the years—but it seems like it's…

Professor #15: Yep. It's gotten…

Paul: Yeah. And my…and my…my thing was, I didn't—I enjoyed meeting the foreign students and stuff, I just wanted to see some Mississippians. Or at least…

Professor #15: Right.

Paul: Mainly, I just thought it would be good for our state. And, that's one reason I was…I was interested in this study.

Professor #15: One thing that disturbed me, you know, is they put these graduate students that were not good English speakers teaching labs.

Paul: Yes sir.

Professor #15: And then they hired professors that didn't speak English well, to teach the courses. And, uh…

Paul: Um hmm.

Professor #15: …that's a big mistake, too, in my opinion. That's…that would be one reason that would turn students off.

Paul: Yes sir.

Professor #15: Umm…

Paul: Well, I know that in my time, it was useful—I learned from many types of teachers—but it was always sort of a comfort to have a teacher that sort of understood your background. It was like they understood it better…

Professor #15: Right.

Paul: …and they could explain it better. And…and I think the most important thing is: they knew where you came from academically. Like, your systems of academics were the same. So, you know, it's like—it just worked better. I don't know if you know anything about—if you've seen any of that in your studies, but…I imagine you've seen a lot more than I have, because you've been a teacher, but… [laughing softly]

Professor #15: [laughing softly]

Paul: But, anyway …. Well, do economic factors play a large part in students choosing to pursue or not to pursue graduate studies in physics?

Professor #15: I think they do, because…with the same amount of work and the same amount of talent, in my opinion, students can go into engineering, for example, and some other areas as well. And, for the same effort, they can come out with jobs that pay a lot better.

Paul: Yes sir.

Professor #15: And, the number of jobs for physicists, I think, in recent years has not been all that great. That's…of course, I've been out of teaching for [many] years, and kind of lost track of some of it. But, uh, that's my opinion…

Paul: Yes sir.

Professor #15: …that the job market is not as good for them, and they—for that reason—choose other fields, for example.

Paul: Yes sir. Well, what were the key factors, in your opinion, to your success in physics?

Professor #15: Well, one was: I grew up on the farm, and I didn't want to spend my time plowing a mule, you know, and cutting firewood, and stuff like that. I was highly motivated to go to college and get an education, you know, and get a job that required an education—that was one of the things. And, I was used to working hard. I expected to work hard.

Paul: Yes sir.

Professor #15: And, I did work hard. I mean, I'm not the smartest person in the world, but I work about as hard as most of them do.

Paul: Yeah.

Professor #15: And, I think that was part of my success. And then, of course, I had some good teachers along the way. And, you know, we had the assistantships. That helped out. I couldn't have done it. Another thing: I had several friends, you know, who got married and had to drop out, or they had to get a divorce because, you know, if you don't have any money…[and] you get married, you're liable to have all kind of financial troubles.

Paul: Yes sir.

Professor #15: So, for that reason, I just told myself I was going to wait.

Paul: Yes sir.

Professor #15: And so, that's part of it. I just stayed away from women, mostly. [laughing]

Paul: Yeah. [laughing]

Professor #15: I didn't want to be side-tracked.

Paul: Yeah.

Professor #15: That's one thing. And, then I had some good mentors. Dr. Howell wasn't the best teacher in the world, but I mean, he was a really a top notch guy; and he helped me along the way. And Dr. Hamilton has always been a big help…and some other people. A guy named Mr. Clifford Rose that you may hear people talk about, he was on the faculty here; and he was an outstanding teacher.

Paul: Yes sir. Well, what could be done to make the Mississippi education system better for producing physics students who will be in a position to have a successful career in physics?

Professor #15: Well…one thing they need to do is: make the high schools do a better job of preparing people in mathematics and science. That would be one thing. That's essential. They've got to do a better job. And the other thing—if you want to attract people—one way to do it, you know, is to have some kind of economic incentive. Have some scholarships that these people can get. Without those fellowships, brought on by our competition with the Russians, I might not have made it. And so, that's another thing. And then…having jobs that these people can get once they get the degree. Those are the three things I can think of off the top of my head.

Paul: I think that…that sounds like some good ideas to me, so.... [laughing]

Professor #15: [laughing softly]

Paul: Well, do you have anything else that you would like to say about physics…that you can think of?

Professor #15: Not really. But, uh, I really enjoyed being in physics. But, as you can see, I came in at an opportune time. Because, the space program was just starting; the nuclear program was getting going; and, I got involved a little bit in both of them, you know.

Paul: Yes sir.

Professor #15: And one thing, I enjoyed being able to come back to my, basically, my hometown to get a job…

Paul: Yes sir.

Professor #15: …and, uh, spend most of my time here, and go out to various places, you know, to get some experience, which was valuable.

Paul: Well that's good. Well, I thank you for conducting the interview with me, and if you don't have any other questions or comments, I guess that's the end of our interview.

Professor #15: OK, well…I hope you do well with your dissertation, and I hope it makes a positive impact on the state and the country.

Paul: OK. I…

Professor #15: Mississippi's not the only place, you know. [chuckling]

Paul: That's right! That's right! [chuckling]

Professor #15: Yeah. [chuckling]

Paul: I'm hoping we can start here, and then maybe…maybe expand to…

Professor #15: Yeah.

Paul: …broader things.

Interview with a Native Mississippian Physicist, Labeled here as Professor #16, (July 2013 at a University in the State of Mississippi)

Paul: I'm doing an interview with [a professor] from the University of Southern Mississippi. And, I would just like to ask a few questions about physics. Why did you choose to pursue a career in physics?

Professor #16: I think primarily because I had a good physics teacher in high school. I had always—up until my senior year, all the way through my junior year of high school, I had assumed I was going to go to medical school. And, I wanted to be a physician. I was in a Boy Scout explorer troop that met at a hospital and studied medical things…you know, medical issues. And, [I] really assumed I was going to be a physician. And…but, my senior year of high school, I took physics for the first time. And, I had a really good high school teacher. And, I just really loved that class. I really loved physics. I had never been a real fan of chemistry in high school. But, once I took physics, it really got me more interested in, I would say, the hard sciences (as opposed to the life sciences). And, I really became more interested in that, and I went to undergraduate school here at USM. And, I started out as a computer science major, actually—I was interested in computers, too. But, I thought I was going to minor in physics. And I thought, "OK, I'm going to learn how to program computers, I'm going to minor in physics, and I'm going to be programming the space shuttle one day" or something, you know. [laughing]

Paul: Yep.

Professor #16: And so…um…but, after a couple of years of being a computer science major, I realized that my physics classes were really my favorite classes.

Paul: Um hmm.

Professor #16: And so, I decided to switch my major to physics. But, I don't think I ever would have decided to minor in physics or even would have looked at a hard science type career if it hadn't been for that good high school physics course. Because, in that high school physics course, he handed out some brochures that showed people working with lasers, working with, you know, all sorts of advanced aerospace types of things…and then a physics career. And that really appealed to me, you know. And I finally understood, "Oh, physicists are the people that get to do that kind of stuff."

Paul: Yep.

Professor #16: And so, I think that idea stuck with me…because of that high school physics class.

Paul: OK. Well, what obstacles did you have to overcome during your years as a student and during your years as a physicist?

Professor #16: Um…I think, primarily, I would say the main obstacle was just my own confidence, a lot of times. I had good high school math and science. I had excellent math and science at USM as an undergraduate, I felt like. Had a little bit, maybe, of a chip on my shoulder…kind of believed some of the media stuff you hear on TV about Mississippi, that maybe we weren't quite up to…

Paul: Yep.

Professor #16: …up to speed with everybody else. And so, when I got to [a prestigious university in another state] in graduate school, I had a little bit of a confidence deficit that I had to overcome.

Paul: Yep.

Professor #16: But, pretty soon, I figured out that, you know, my background from USM as an undergrad—my physics preparation and my math background at USM—was as good as everybody else's.

[*Note: At this point in the interview, someone knocked on the door. They came in and discussed some items with the professor; thus, the interview was briefly halted until the other people had left the office (a few minutes later). At that time, the interview was resumed. Thus, the recording starts back from that time.*]

Paul: Yeah, you were talking about the obstacles that you had faced as a physics student at [the prestigious university in another state], so…

Professor #16: Yeah, so I got there, you know, and I'm in grad school with guys who had gone to kind of what you might consider some "big name" schools. You know, had some Ivy League kids there, guys who'd gone to school at, you know, what you would think would be "bigger name" institutions, you know.

Paul: Uh huh.

Professor #16: And so, I had a little bit of…like I said, a confidence deficit, perhaps, going in. Um, you know, thinking, "Well, maybe," you know, "I'm just some kid from Mississippi. I'm not really going to compete with these guys as well."

Paul: Yep.

Professor #16: Not that anybody—when I was growing up here, nobody told me that. I just assumed that because you always hear bad stuff about us on the media. You know, we kind of believe our own bad press, sometimes.

Paul: Yep.

Professor #16: But, I figured out—after, you know, that first year or so—I kind of figured out, "Hey, these guys aren't any different than me."

Paul: Yeah.

Professor #16: And so, you know, that was probably a little bit, you know, somewhat of an obstacle: just my own self-confidence in my abilities to keep up. That was probably the biggest obstacle.

Paul: OK.

Professor #16: Because, I was fortunate—and a lot of people don't have this opportunity—but I was fortunate through high school to have really, really good math and science teachers. I think that was critical.

Paul: Yep.

Professor #16: And so…

Paul: And, that was at Hattiesburg at…

Professor #16: That was Hattiesburg High. Yep.

Paul: OK.

Professor #16: Um hmm. Back in the early Eighties. And, uh, I had great Ninth through Twelfth Grade math; really good Tenth through Twelfth Grade science.

Paul: Yeah.

Professor #16: And, I think my success really goes back to that…and then, you know, the preparation I got in my undergraduate degree.

Paul: OK.

Professor #16: But, I would say the obstacle, really, was…was, leaving Mississippi, just my own confidence.

Paul: OK. Well, I was wondering—this is a little different question—but did you have calculus in high school?

Professor #16: No, I didn't. I didn't. I could have!

Paul: OK.

Professor #16: I was a little lazy my senior year. [laughing]

Paul: Yeah. [laughing softly]

Professor #16: Basically, we didn't have any—at the time, we didn't have, like, advanced math classes. The way it worked when I was going through, you took Algebra in the Ninth Grade, Algebra II in Tenth Grade, Geometry in Eleventh Grade, and Trigonometry in the Twelfth Grade. And then, if you wanted to—I mean, that was kind of the standard college prep kind of curriculum in our high school—and, if you wanted to, you could take Calculus as an elective.

Paul: OK.

Professor #16: And, I was kind of lazy, and I didn't do it. [laughing]

Paul: [laughing softly]

Professor #16: But, I didn't do it. And, um, but I took it my first—but, the good thing was, all the teachers I had through Algebra I, Algebra II, Geometry, and Trig [Trigonometry], through high school, were outstanding teachers. They were really good. So, when I got to college, in my first semester, I took Calculus. It was no big deal. It was just like taking the next class in high school. It really was not a big deal.

Paul: And, you had it, you said your first year of college? Like, Calculus?

Professor #16: Yeah, I took Calculus my first semester of my Freshman year.

Paul: OK.

Professor #16: In the fall of my Freshman year.

Paul: OK.

Professor #16: But again, I was only able to do that because, you know, I had had such good high school math. And, my senior year, my trig teacher was actually—uh, and it's probably something they might call "pre-calculus" now, a lot of what we did and things like that—um, my teacher was actually a USM instructor, for the math department at USM.

Paul: Now which teacher? Are you talking about your algebra …?

Professor #16: My senior…my senior trig teacher for…for trig.

Paul: Oh, your trig teacher. OK.

Professor #16: In my senior year, the lady who had been teaching trig and calculus at Hattiesburg High left for another job. And so, they brought in an instructor to fill in on trig and calculus, who was from USM.

Paul: Oh.

Professor #16: And so, she was already a college teacher.

Paul: Yep.

Professor #16: So, I kind of got a college trig class…

Paul: Already! [laughing]

Professor #16: …my senior year of high school.

Paul: That's good.

Professor #16: I mean, that's what she was.

Paul: Yeah.

Professor #16: And so, I mean, it just…it worked out great. And…and I know a lot of kids don't have that opportunity in Mississippi. But, for me, that was…I think that was key…you know, was having that good high school math.

Paul: Yep. Well, I guess this is…this is one…one slight question based on that, but did you ever…what did you do whenever you came to those physics classes at the graduate level that…where the math almost looked like another language that you didn't have?

Professor #16: Right.

Paul: Did you ever have that scenario? Or, did you actually build up to it so that you knew it?

Professor #16: Well, I kind of built up to it.

Paul: So, you pretty much knew those…

Professor #16: Our undergrad curriculum, back then at USM—and we still have it to this day—um, requires a huge amount of math. I mean, we're only—I was actually a double major. I majored in physics and math…

Paul: OK.

Professor #16: …as an undergrad. And, the reason was, that our undergraduate curriculum required so much math—up through Differential Equations, Partial Differential Equations, Differential Equations II.

Paul: Yeah.

Professor #16: The physics major required all that stuff. And so, there was only like two more classes to take, and you could have a math degree.

Paul: Hmm.

Professor #16: And so, I did that. I took a couple of extra math classes and got a math undergrad degree, as well.

Paul: OK.

Professor #16: And so, um…and we still kind of have that in our curriculum. Our curriculum now is really only—maybe two or three classes short of a math major.

Paul: OK.

Professor #16: And so, when I got to grad school, um, you know, in our senior level undergrad, like for example Electricity and Magnetism, was certainly not at the level of Jackson E & M, you know…

Paul: Yeah.

Professor #16: …but it was a pretty rigorous course. It was taught from a book (Reitz, Milford, and Christie) which is a pretty…relatively advanced undergraduate text—at least, that version. I don't know what it looks like now. But yeah, so I felt like my preparation going in was pretty good. I mean, I definitely…I struggled with graduate E & M [Electricity and Magnetism]. For example, it was probably the class I struggled with the most—the Jackson course.

Paul: Yeah.

Professor #16: That's probably the class that gave me the hardest time.

Paul: Yeah.

Professor #16: But then again, I think that's…that's pretty common across physics, you know. You won't hear a lot of people say, "Oh, I loved that Jackson class!"

Paul: [laughing]

Professor #16: You know, we don't even call it "graduate E & M." A lot of times, we just say, "I'm taking Jackson." [laughing]

Paul: Yeah. [laughing]

Professor #16: And, yeah, it's…it's a difficult, difficult class. And, it was hard, you know. And, I don't think anything really—there's so much vector calculus, vector manipulation, and those types [of things] in that class. It's just a type of math you just don't see very many other places, except for maybe like Advanced Fluid Dynamics, or something like that. You'll see that kind of stuff in there, too. Um…yeah, so it's different.

Paul: Yeah.

Professor #16: And it's…yeah, it was hard.

Paul: Yeah.

Professor #16: I made a B in the first quarter. [laughing softly]

Paul: [laughing softly]

Professor #16: And, I didn't make a lot of B's in physics as an undergrad. I don't think I made any.

Paul: Yeah.

Professor #16: And, uh…yeah, so I mean, I…you know, I…I was probably lucky to get a B, you know. [laughing softly]

Paul: [laughing softly]

Professor #16: The second semester—the second quarter, [this particular university] was on the quarter [system]—the second quarter, I did a little better.

Paul: Yep.

Professor #16: But yeah, it was definitely an adjustment. I mean, it was a—because, even though I'd had a really good undergrad class, that class is just…it's just hard no matter how you cut it. It's a—it's different, you know.

Paul: Yeah. Well, you may have answered some of these questions a little bit, but the third question that I wanted to ask [is]: Do you think Mississippi students are as well-prepared as other students for the academic rigors of physics?

Professor #16: I think it depends entirely on where they went to high school.

Paul: Yep.

Professor #16: I think there is such a range of possibilities. What we see here at Southern Miss in our incoming physics majors is: we get a large fraction of our majors from a handful of high schools.

Paul: Uh huh.

Professor #16: And, those handful of high schools have really good high school physics teachers.

Paul: Hmm.

Professor #16: And so, it's like, if you're a kid that happens to go to one of those schools—kind of like I did—then the answer is: yeah, I think those kids are maybe very well-prepared. But, I also know there are a lot of schools where physics isn't really even normally taught. The vast majority, I think—I saw some statistics a few years ago—the vast majority of schools in Mississippi don't have a licensed physics teacher. Usually, it's someone who's from another field.

Paul: Yep.

Professor #16: You know, they don't have physics licensure; they may have licensure in something else, and they kind of get an emergency certification in physics or something because they took a physics class in college. Maybe it wasn't what they really wanted to do, you know. So, I think that overall, probably the broadest answer—I don't know how we compare nationwide—but I think in a lot of high schools, it's hard to get a good preparation. It may be hard to get a good preparation in physics. There are certainly schools that do a good job, though.

Paul: Yeah.

Professor #16: So, I think it's…it's probably entirely dependent upon where you go to high school. You know, which school you're in.

Paul: Yeah.

Professor #16: Some schools do a great job at giving students the preparation they need. And, I'm sure there's probably some that don't. And, it's going to be kind of case by case—I mean, in my opinion, this is probably a case by case basis, depending on the school.

Paul: OK.

Professor #16: And, I think…I'm not sure that nationwide, that's not the same answer. We may have some more challenges in Mississippi than…than some states with more resources.

Paul: Yep.

Professor #16: But again, I think it—[in] my opinion, it very much comes down to the individual teachers, the people that are in that high school and the preparation they provide. I just can't overstate the value, I think, of a good high school experience in preparing kids for…for a career, like in physics.

Paul: OK. Well, do economic factors play a large part in students choosing to pursue or not to pursue graduate studies in physics?

Professor #16: You know, I—I mean, this is only, obviously, my opinion, I don't have any statistics or facts to back [it up]—I suspect it does play some role. I think there's probably a strong…and again, this is just my opinion, just from walking around life…

Paul: Yep.

Professor #16: …is that there's probably a pretty strong association between the economic background of a student and the educational background of that student's family.

Paul: Yeah.

Professor #16: I suspect there's…there are some correlations there. They're not one to one; you can't guarantee that a student from a wealthy background comes from a highly educated background. You can't guarantee that a student from kind of an economically disadvantaged background—that their family doesn't have a good educational [background]. But, there's probably a correlation there, you know.

Paul: Yep.

Professor #16: And so, I think, you know, from my background—I grew up in a family that was economically in the middle somewhere. My mother was an English teacher. Dad had a master's of divinity; he was a minister. You know, college, in general, was always just sort of assumed.

Paul: Yep.

Professor #16: And so, I think the economic impact may be that students, maybe, who are first-generation college students—you know, I don't know if they're more or less likely to choose a field that's maybe a little less popular, a little less well known, like physics. I don't know. If you're first-generation college student, do you tend to migrate more toward better known fields where there are a lot more students going into those fields? I don't know. I don't know how that works. But, I mean, physics is a bit of an esoteric…

Paul: Yeah.

Professor #16: …subject in the sense that…there's, I mean, there's very few schools in the nation where anybody would say, "Boy, we had a lot of physics majors!"

Paul: Yeah. [laughing softly]

Professor #16: You know? I mean that just, that's just not—you know, there's always going to be more biology majors, there's always going to be more chemistry majors, than there are physics majors. I mean, not always; but, by and large, [at] most places, I think that's probably true…

Paul: Yep.

Professor #16: …that biology, chemistry, math…I mean, those all tend to seem to draw more students than physics. And again, it may go back to the fact that if you have an economically disadvantaged student, who went through an economically disadvantaged high school that didn't have a strong physics teacher, then, yeah, there may be a correlation there…um, that gets set up. Not because they're not just as smart as everybody else—you know, being economically disadvantaged doesn't make you any less smart than anybody else.

Paul: Yep.

Professor #16: But they may not have had the educational opportunities along the way that would encourage a student to pursue something a little bit more of a—and "esoteric" is not the right word, but that's all I can come up with at the moment—uh, that type of discipline.

Paul: Yeah.

Professor #16: So I suspect there is a tie [i.e. a connection], you know, between there.

Paul: Well, I was wondering—like, this is just sort of an elaboration of that—but, when you were in graduate school at [the university where you got your graduate degree], did you find it very worrisome, as far as economics...as far as the ability to get through the graduate school? Or, did you pretty much have the support that you felt [you needed]?

Professor #16: That's an excellent question, and that's an excellent point. And, the answer is: no, I wasn't worried because—I mean, you're always worried; you always want to be self-sufficient. You know, when you're in grad school, you want to be self-sufficient. But, I had a family structure that I knew I could fall back on.

Paul: Yeah.

Professor #16: So, yes, that was an impact. I knew I had a safety net in the event that—I mean, because, yeah, I mean, it's hard being a poor graduate student. You know?

Paul: Yeah.

Professor #16: And so, if I had not had the family background or kind of the family back-up that I had, kind of that safety net, um…then, yeah, it would have been much more terrifying…[laughing]

Paul: Yeah. [laughing softly]

Professor #16: …to be living paycheck to paycheck.

Paul: Yep.

Professor #16: You know? But, I always kind of knew, "Well, if I really got into trouble, my family would back me up." I had a safety net. And so, yeah, that's a key point.

Paul: Yep.

Professor #16: I think that is a key point, you know, that if you've got a little bit more economic support, family wise, maybe you're more likely to say, "OK, I can make a lousy salary for a few years and go work on a graduate degree."

Paul: Yeah.

Professor #16: Whereas, if you don't have any kind of back-up like that, it might be tougher. Yeah, I think that's a key point. That is a very good point.

Paul: Well, what were the key factors, in your opinion, to your success in physics?

Professor #16: The key factors to my success in physics…I think…in large measure…um…it…I mean, there's obviously any individual student's personal drive to do something. And, so that was part of it. I had to drive to go get a PhD. I always wanted to be a college professor. Once I kind of got into physics, I really thought, "I want to be a physics professor. Really what I want to do." And so, I kind of did the things that I had to do to get to that point. However, the real key factors in my success were probably, honestly, being fortunate enough to hit the right people at the right time in my life; to encounter good math teachers and good physics teachers in high school (or a good physics teacher in high school); to encounter good math and good physics teachers in college as an undergraduate; for them to encourage me that I had the capability to do this.

Paul: Yeah.

Professor #16: So really, the key factors to my success in physics…a lot of it's kind of luck, I mean, in a way. I hit the right people at the right time.

Paul: Yeah.

Professor #16: And, if I had not had that good high school physics teacher, or if my first calculus teacher in college had been a dud, um…who knows? [It] could have turned out totally differently. And so, I was fortunate enough that everywhere along the way, I had other people who helped me be successful.

Paul: Yeah.

Professor #16: And so, I would say that's the key factor, more than my personal abilities. It was kind of being fortunate enough to be in the right place at the right time.

Paul: Yeah.

Professor #16: And maybe that's different for other people, but I think for me, that's really what it was.

Paul: OK. Well, the last question that I have is: what could be done to make the Mississippi education system better for producing physics students who will be in a position to have a successful career in physics?

Professor #16: Well—and I think this is a question that addresses Mississippi…[it] goes nationwide, really—um, I think…I mean, I don't know…I don't know that I really understand what it is that I can quantify what makes a good, encouraging teacher versus one that's not.

Paul: Yep.

Professor #16: It's kind of like one of those things, "you know it when you see it."

Paul: Yep.

Professor #16: So, I have a hard time quantifying exactly what could be done. But, I think, in large measure, we have to invest in our high school math and physics teachers.

And really, high school is probably too late. It goes all the way back. You've got to get, you know, the educational system starting when kids are young…

Paul: Yep.

Professor #16: …trying to engage them in not just memorizing facts and figures, but—and certainly there are people in the education fields that know a lot more about this than I do—but it just seems to me that it's a matter of not teaching them to take a test, necessarily, or teaching to a test ("we have to pass this test, memorize these things"). It's much more about kind of, you know, bringing in activities and things that they can be a part of. I don't really know, honestly. I honestly don't know, other than: we have to make it a priority…for good teachers. And, there's a ton of good teachers in the system, but the system doesn't always reward them like it should.

Paul: Yeah.

Professor #16: I think, by and large, we do not reward our elementary and high school teachers the way we should. We don't necessarily always take into account the dramatic impact that they have on people's lives.

Paul: Yeah.

Professor #16: You know? And so…I don't know, it's nationwide. It's…it certainly is true in Mississippi, but I think it's true everywhere…that we as a culture have to value that, and put our money where our mouth is, and be sure that we pay teachers adequately enough we get people in the classroom who want to be there.

Paul: Yep.

Professor #16: And, you know…so I don't have any really good, specific—like do x, y, z, and it's all going to be better, you know.

Paul: Yep.

Professor #16: I don't know, I think it's a…it's a…a lot of people who know a lot more about it than I do have spent a lot of time thinking about that question. But for me personally, it comes down to people.

Paul: Yep.

Professor #16: It's not about, "Hey, let's get laptops on every desk." OK, maybe that's useful, maybe that has some value. I mean, I'm not saying that's a bad thing. I'm just saying that giving kids a bunch of laptops in a room, without a solid teacher to work with them, is not going to generate success. It's not a technology… it's not a technology answer, I don't think…I don't think the answer is, um…it's not just financial, it's not just technology, it's about people; and people inspiring kids to want to do these things.

Paul: Yep.

Professor #16: And, I was fortunate enough to have that. And, that's why I was successful, I think. And, I don't know how you replicate that…everywhere. But, I mean, that's fundamentally, I think, what has to happen. It's a people thing; it's not a…it's not a technology thing. It's having the right people to inspire kids to want to do it, you know… I guess. [laughing]

Paul: Yep. Well, I thank you…

Professor #16: Sure.

Paul: … and unless if you have anymore questions or comments, I guess that's the end of our interview.

Professor #16: OK. Alright.

Paul: Thank you.

Professor #16: Sure.

Interview with a Native Mississippian Physicist, Labeled here as Professor #17, (July 2013 at a University in the State of Mississippi)

Paul: My name is Paul Rogers, and I'm doing an interview with [a physics professor]. He is a Mississippi physicist. He grew up in Mississippi. But, the first question that I would like to ask is: Why did you choose to pursue a career in physics?

Professor #17: Well, I loved physics the first time I took the course. I graduated from [a small high school not far from the Jackson area]. And that's…was…had the same instructors they had at the junior college, it was then.

Paul: Yes sir.

Professor #17: And, uh…I had…Breazeale was his last name. But, I loved physics. So I took as much physics as I could. Physics and chemistry and mathematics was principally what I took when I left junior college and went to Millsaps College. But, actually, physics chose me, I think. It was at a time—this was in…I graduated from Millsaps in [the 1950s]—and that was a time where the Atomic Energy Commission had been formed, back in the late forties under President Truman. And, they were pushing to get people into atomic energy fields.

Paul: Um hmm.

Professor #17: I was married at the time, expecting our first child. The Atomic Energy Commission offered me a nice fellowship to go to Vanderbilt University, which I did. And, I left Radiological Physics after my Master's degree and stayed on at Vanderbilt to get my PhD in physics.

Paul: OK. Well, did you have a father or someone that…like a father that was in physics or something very similar that sort of inspired you to go into such a heavy science field? Or, you just naturally…just liked it?

Professor #17: No…well, I explained it this way—no, my father died when I was 7 years old, and he was an eighth-grade high school…he went through eight grades…had a GED degree…but he studied law and was a practicing attorney when he died, here in Mississippi, in Jackson. And, nobody pushed me. It's just when the World War II came along there was heightened interest in technical fields. Beside when I grew up as a kid, there were lots more kids in the neighborhood than there are now. The older kids sort of looked after the younger kids, and I was always the youngest kid, so I did all the things that they did. We made kites that would pick you up off the ground in the high winds of March, and we built model airplanes, and that sort of thing. And, I loved all that sort of stuff; so when they got into the mechanics of it in physics, it was already of interest to me. And then, who could not be interested in modern physics? You know, it's just…

Paul: Right. It is interesting. [laughing]

Professor #17: So, I didn't really have any obstacles to overcome. Matter of fact, I feel like I've led a blessed life.

Paul: Yep. Well, that sort of leads into the next question, I guess, and it…I guess you may answer it in sort of almost the same way…but what, if I was to ask, what obstacles did you have to overcome during your years as a student and during your years as a physicist? Like, were there some things that—even though you said it was not really obstacles—were there, thinking back on it, were there some things really?

Professor #17: I…there are always difficulties that one encounters. And, when I was at Vanderbilt, the person who was developing (for his PhD) a time-of-flight spectrometer left and didn't complete it. And, I'm not an electronics expert. And, I and a colleague, who is now out in California, had to get that time-of-flight instrument working. And, I think it was only by an epiphany that I got it to work early one morning. And, as it turned out, I think we had the best time-resolution of anybody in the nation…

Paul: Hmm.

Professor #17: …at that time. It was only a sixty-four channel analyzer.

Paul: Uh huh.

Professor #17: And, uh…but once I got by that, everything else has been a sort of smooth sailing. I sort of get along in physics anywhere.

Paul: Yeah.

Professor #17: I mean, I love all of physics.

Paul: Well, I guess...I know Vanderbilt has—and, both Millsaps and Vanderbilt, have a good academic reputation—so, maybe that helped you have a good background.

Professor #17: Well, I'm sure it did. Millsaps, at the time I was there, had one physics professor there. His name was Charles Betts Galloway. Very nice man. And, he taught all the physics at every level. And, everybody in my graduating class that majored in physics was going to med school, except for me.

Paul: Hmm.

Professor #17: And, uh, I was not interested in medicine at all. It's just not something that interests me…although I did work at the medical school when I was at Vanderbilt…

Paul: Hmm.

Professor #17: …for a while in the radiology department over there. Just to earn money.

Paul: Yeah…. Do you think that Mississippi students are as well-prepared as other students for the academic rigors of physics?

Professor #17: I don't know that I'm in the position to gauge about Mississippi students in general, now. I've been away from that arena for a long time; except that I do have a son who's a freshman at [a Mississippi university] this fall, who took AP physics this last semester at [a high school in Mississippi]. And, I do have some opinions about that. And, my thoughts are that they do well for the people who are capable students and the like; but, there is only one physics teacher, and so being able to serve in other capacities is tough for him. He does it. He's a good man.

Paul: Uh huh.

Professor #17: And, I think their program here is good for the good students. I have somewhat of a reserved opinion about what schools in Mississippi, in general, do for the average person that comes through school. I do not believe in an elite school system in public schools. Not that you can't demand of people things; I'm not suggesting that. But, you give all students your maximum effort…

Paul: Yeah.

Professor #17: …that you can give. And so, I can't really speak to everybody, but certainly the students from [the high school previously mentioned] go on and seem to do well everywhere.

Paul: Yeah.

Professor #17: But, I suspect it's the way that it always has been. And that is, they have so few physics teachers that they don't get many takers in the high schools. It's kind of tough to have somebody imagine they could be interested in physics until they get in and start doing it.

Paul: Right.

Professor #17: But, you have to do it. You can't talk to them about physics; you have to let them do all the things you do.

Paul: Yeah.

Professor #17: And, physicists understand that. But, they just don't have the equipment, money, time, teachers, to do that sort of thing. So, it's…it's just sort of where we are, it seems to me.

Paul: Yeah. Well, do economic factors play a large part in students choosing to pursue or not pursue graduate studies in physics?

Professor #17: It was my principle reason for accepting the Atomic Energy Commission Scholarship way back in 1954. I mean, I had to have something, and I was working at the highway department as a—they called me a "topographical engineer"…I drew maps. And, I knew I didn't want to do that at the pay that they had. And this [Radiological Physics] really sounded of interest, so that's where I went. Economics always plays a factor, because with this a capitalist country, people feel like they're not doing well if they don't make a pretty good salary. I do not know many people who left a position that they loved just for more money.

Paul: Yeah.

Professor #17: OK. I've known people to leave their position for more money…

Paul: Yep.

Professor #17: … and that sort of thing. But, no I…I'm sure a lot of this is personal prejudice, but having been born and raised in Mississippi, we're sort of backwards. And, we don't understand we're backwards. And, in 1985, when I was at the Institute for Technology Development, I got to visit the legislature some, and…those guys are backwards when it comes to mathematics, science, and development in this country. But, I can say—just having learned from [a close acquaintance] being a [student] at Ole Miss [recently]—the University of Mississippi has made a significant effort…

Paul: Yeah.

Professor #17: …to give students with the interest an opportunity to develop their talents at whatever level they decide to develop them...

Paul: Yeah.

Professor #17: …with all of the programs they have going on here. And, that's a plus for the University of Mississippi. Maybe they do that at other places, I don't know. I think that I'm out of it, I don't really know.

Paul: Yeah. Well, those are good answers. Because, as you mentioned, your principal reason was an economic factor—or one of your main principal reasons, as you mentioned, for going into physics. So…

Professor #17: Well, they paid me more in that fellowship, than I made working a full forty-hour week at the Mississippi State Highway Department.

Paul: So, it sort of made sense. [laughing]

Professor #17: Yeah.

Paul: Well, what were the key factors, in your opinion, to your success in physics?

Professor #17: Well [chuckling], all of my colleagues would argue [about] what success I've had in physics. But, mine is versatility.

Paul: Uh huh.

Professor #17: I got my PhD doing low energy nuclear physics. I went to work in industry at Sperry Microwave, a division of Sperry-Rand Corporation. And, I did work in cryogenics with superconductors. Prior to that, I had never had a course in solid state physics at Vanderbilt. At Sperry, I started work in ferroelectrics in solid state physics. I have chased storms while making lightning measurements—not as detailed as what [another professor here at Ole Miss] does—but, making measurements of thunderstorms.

Paul: Yes sir.

Professor #17: All of interest. But, it has to do with me as a peculiar person. I am not the typical physicist. I am a holistic thinker.

Paul: Yeah.

Professor #17: That's not someone who thinks it's the traditional—I ask lots of questions. But, most physicists wonder why I asked that question.

Paul: Yeah.

Professor #17: So…I'm just peculiar, and I understand that.

Paul: Well, maybe that's true of Mississippi physicists [laughing]. Because, I think I'm a little that way in that I'm more of like a philosopher/physicist. You may not be like that, but I'm more of…I'm interested in everything. And, that's why I'm interested in physics.

Professor #17: Yeah, well, at some level, I think that plays an important part in Mississippi, that it seems to me on a national scale that physicists somehow are put out because they don't get as much recognition and power and authority as they should get. And I say, "Why should they?" You're just a small group of people, and there are over seven billion people in the world—and just a tiny little fraction of them are scientists. So, why do scientists think that they ought to run the world, just because they have a different vision of what's truth?

Paul: Yep.

Professor #17: Yep, and so, it's tough for people to catch on to that in science, but the converse of that (or the inverse, I should say) is tough for people who don't know anything about science to catch on to.

Paul: Yeah.

Professor #17: It really is in the benefit of the state of Mississippi to have programs where the kids from Mississippi can learn to be involved in technology; because technology is here, it will be for a long period of time.

Paul: Uh huh.

Professor #17: And, you know, on campus they have this…uh…Haley Barbour Institute. What's it called, a manufacturing institute or something? And [someone I know] went to an open house that they had there and participated in it for a day. And he said, "It's kind of fun." They're trying to prepare people to go into industries in Mississippi…

Paul: Yeah.

Professor #17: …so that industries don't have as tough of a time bringing people up to speed to do the things they want to do.

Paul: Yep.

Professor #17: Mississippi's a good place.

Paul: Yeah.

Professor #17: Mississippians are good people.

Paul: Yeah.

Professor #17: But, we just drag our feet sometimes too much—concerned about the wrong sort of things.

Paul: Yeah. Well, what could be done to make the Mississippi education system better for producing physics students who will be in a position to have a successful career in physics?

Professor #17: Don't know the answer. I think we do a pretty good job. If you want to be a physics major and go on and get a PhD in physics, Oxford's school system does a good job. OK. Some students come over here [to the Ole Miss campus] and take university courses; mathematics, whatever. So, the opportunity is there, here. It's probably available at State [Mississippi State University] and Southern [University of Southern Mississippi]. I don't know about Jackson State, Tougaloo…. Delta State, it was somewhat that way, but not as elaborate as it is at Ole Miss and State. So, I think good students are hard to hold back. If you give them a way to—if they know what they want to do, and you give them a way to get there, they get there. And, I'm not sure that is relevant to the national scene. It would be tragic to hold back some of the bright students—they've had some really bright students come through this place.

Paul: Yeah.

Professor #17: And, it's good that they go on and can go to the top notch universities and laboratories, because much of the world's premiere science is done there. But there's a great deal of need for science graduates, physics included, that is not pursuant of a PhD.

Paul: Yeah.

Professor #17: OK. And, that's the area which I think would help Mississippi. A person who's interested in all areas of physics, and knows physics, is a good employee. When I was at Sperry Microwave, the first group that I had with me had three engineers and one physicist (B.S. in physics)…

Paul: Uh huh.

Professor #17: …and then myself. And, it was a good group. It was a good functioning group. What we set out to do, we got done efficiently.

Paul: Yeah, that's good.

Professor #17: So, there's a need for physicists out there, because they look at the world differently than the engineers.

Paul: Yeah.

Professor #17: Especially when they're young and fresh out of school.

Paul: Yep. I think that's true. Well, I thank you for helping me with the interview, and unless if you have any other comments or questions about Mississippi physics, I guess that concludes our interview.

Professor #17: OK.

Main Answers from the Interviews with the 5 Successful Mississippi-Native Physicists (Separated Out Question by Question)

The researcher, in the following pages, has listed each question from the interview form with the successful Mississippi-native physicists [see *Qualitative Survey Form (Interview with Successful Mississippi Physicists)* in Appendix C]. The researcher endeavored to ask these questions (which were on the interview form) during the interview with each of the five successful Mississippi-native physicists. These "successful Mississippi-native physicists" were five physicists who were born in the state of Mississippi, except for one case in which the professor moved to Mississippi as an infant (rather than being actually born here); these Mississippian physicists worked in the past (or work presently) at universities in the state of Mississippi. The full transcripts show the complete context of precisely how each question was asked to each Mississippi physicists. After the researcher had typed up the complete transcripts, the researcher later went through the transcripts and carefully selected out the "main answer" of each professor (or physicist) to each of the interview questions (on the interview form) which was asked of him or her. In the following pages, these main answers the professors gave to the interview questions are shown.

Main Answers from Interviews with 5 Successful Mississippi-Native Physicists (Question #1):

(1) Why did you choose to pursue a career in physics?

Professor #13: Well, I don't have a real clear answer to that. I started out in engineering, in pre-engineering in community college; and, at some point, I decided I didn't want to do that anymore, and I picked physics. But, it could just as easily have been chemistry.

Professor #14: Well, there are really two branches here. My father was a geophysicist, and so he was always interested in sciences and teaching us about science. And then, in high school, at…our physics teacher in high school was a physics grad student from [the nearby college]. And, he did a good job teaching, and made it interesting. And so, I did physics as an undergrad degree; and looked at math a couple of times there, but ended up getting the degree in physics.

Professor #15: Well, I grew up out in the country from Mississippi State, out at a [small community]. Went through the eighth grade there. Had good teachers, as a matter of fact. But, the population down there was so small that they closed the high school. […] And, then I transferred up to [the nearby city high school] which was an excellent school at that time, and I think it probably still is. […] There, I got good courses. I had trig [trigonometry], and I had algebra and some advanced courses in mathematics. I had chemistry. I had physics. I had a good physics teacher. And, I'd always been interested in things. […] And, I did well in [the nearby city high school]. And, you know, physics had the reputation of being tough. So, I think it was kind of a challenge. That's one thing that got me to do it. I enjoyed the stuff, and I could see, you know, that there was a lot going on in the world. And, I thought it was kind of a challenge. I just wanted to try it.

Professor #16: I think primarily because I had a good physics teacher in high school. I had always—up until my senior year, all the way through my junior year of high school, I had assumed I was going to go to medical school. And, I wanted to be a physician. […] But, my senior year of high school, I took physics for the first time. And, I had a really good high school teacher. And, I just really loved that class. I really loved physics. […]

I went to undergraduate school here at USM. And, I started out as a computer science major, actually—I was interested in computers, too. But, I thought I was going to minor in physics. […] But, after a couple of years of being a computer science major, I realized that my physics classes were really my favorite classes. And so, I decided to switch my major to physics. But, I don't think I ever would have decided to minor in physics or even would have looked at a hard science type career if it hadn't been for that good high school physics course. Because, in that high school physics course, he handed out some brochures that showed people working with lasers, working with, you know, all sorts of advanced aerospace types of things…and then a physics career. And that really appealed to me, you know. And I finally understood, "Oh, physicists are the people that get to do that kind of stuff."

Professor #17: Well, I loved physics the first time I took the course. I graduated from [a small high school not far from the Jackson area]. […] [We] had the same instructors they had at the junior college, it was then. […] I took as much physics as I could. Physics and chemistry and mathematics was principally what I took when I left junior college and went to Millsaps College. But, actually, physics chose me, I think. It was at a time—this was in…I graduated from Millsaps in [the 1950s]—and that was a time where the Atomic Energy Commission had been formed, back in the late forties under President Truman. And, they were pushing to get people into atomic energy fields. […] The Atomic Energy Commission offered me a nice fellowship to go to Vanderbilt University, which I did. And, I left Radiological Physics after my Master's degree and stayed on at Vanderbilt to get my PhD in physics.

Main Answers from Interviews with 5 Successful Mississippi-Native Physicists (Question #2):

(2) What obstacles did you have to overcome during your years as a student and during your years as a physicist?

Professor #13: Really, I don't think I had any obstacles.

[*At this point, the professor was questioned further about whether or not the professor felt well-prepared academically at Vanderbilt.]* Yeah. I was very well-prepared at Mississippi State to go to Vanderbilt. Better prepared than most of my classmates were. Most of the Vanderbilt students came from small schools someplace…from all over the country. But, very few of them came from Ivy League schools or schools you would think of as being superior to us in some ways. So, I was as well-prepared as any of them.

Professor #14: In college we got a young visiting professor who […] [was] teaching quantum mechanics, and this professor—the books weren't in—and so he lectured on the math involved with quantum mechanics. So, we got the math books about two weeks before the exam, and—we got the physics text—and I studied all the math, and the test was all on what was in the physics book, and I didn't do very well on that. And, that was pretty discouraging. But, I bounced back from that. And, it sort of affected what sort of grad school I could go to.

Professor #15: Well, one of them was, you know, I was the first person in my family to go to college. And, we were not well-off. And, uh, I remember when I first started, I was working part-time as a clerk at JC Penney […]. But, I was doing that, and then I got so busy studying physics and chemistry and stuff like that, that I had to quit working there. And then, uh…you know, it probably put a—I didn't think about it at the time—but, it probably kind of put a burden on my father supporting me, even though tuition and things were much lower then (but, salaries were, as well). So, uh, that was one of the things. And then, uh, I didn't know where to go to graduate school. I looked around at Ole Miss and LSU and Alabama and Vanderbilt. And, Dr. Howell had a master's degree from Vanderbilt, and he encouraged people to go up there. And, I think it was a very good choice. […] And, in fact, after my first year at Vanderbilt, I got a job down at Huntsville working for the Army Rocket and Guided Missile Agency, because NASA hadn't been formed at that time […]. And, uh, then when I got back to Vanderbilt, they had just hired, uh—I don't know if you've ever heard of him or not—Joe Hamilton, who is a well-known nuclear physicist now. […] They'd just hired him. And, the department head called me and said, "Well, I see you did some nuclear work down at Huntsville, and we've got a new guy, and if you'll go to work for him, we'll give you an assistantship," which was a big break. I mean, uh, my…I mean, I would look at my bank account sometimes, and I would be into double digits…my bank balance. Uh, I didn't have it particularly easy, but working with Hamilton was good. And, then, he had contacts, of course, at various places.

Professor #16: I think, primarily, I would say the main obstacle was just my own confidence, a lot of times. […] [I] kind of believed some of the media stuff you hear on TV about Mississippi, that maybe we weren't quite up to…up to speed with everybody else. And so, when I got to [a prestigious university in another state] in graduate school, I had a little bit of a confidence deficit that I had to overcome. But, pretty soon, I figured out that, you know, my background from USM as an undergrad—my physics preparation and my math background at USM—was as good as everybody else's. And so, you know, that was probably a little bit, you know, somewhat of an obstacle: just my own self-confidence in my abilities to keep up. That was probably the biggest obstacle.

Professor #17: There are always difficulties that one encounters. And, when I was at Vanderbilt, the person who was developing (for his PhD) a time-of-flight spectrometer left and didn't complete it. And, I'm not an electronics expert. And, I and a colleague, who is now out in California, had to get that time-of-flight instrument working. And, I think it was only by an epiphany that I got it to work early one morning. And, as it turned out, I think we had the best time-resolution of anybody in the nation…at that time.

Main Answers from Interviews with 5 Successful Mississippi-Native Physicists (Question #3):

(3) Do you think that Mississippi students are as well-prepared as other students for the academic rigors of physics?

Professor #13: Well, I think it varies greatly from one school to another. And, there's some very good schools in Mississippi, and people come out of them very well-prepared.

But, of course, there are very poor schools in Mississippi where very few students come out well-prepared for a college physics course. So…it varies a lot. […] I think we probably have more weak schools than most states.

Professor #14: We’ve got a lot of rural areas where the students are not well-prepared; we’ve got some excellent high schools throughout the state that do a good job of preparing students. But, you know, there are just places that don’t have…well, they’re just not as well-prepared, so…. Ole Miss has been doing good at attracting a lot of the well-prepared students, and so, things are better. But, uh, you know, it’s something that would be nice to see the state improve.

Professor #15: That’s hard to say, because I don’t have experience teaching students from many other places. We have a few students come in from Alabama and Tennessee and some of the local places […]. I don’t think our students are prepared as well as they should be, but it’s difficult for me to say whether they’re prepared as well as the average student throughout the country—but I doubt it.

Professor #16: I think it depends entirely on where they went to high school. I think there is such a range of possibilities. What we see here at Southern Miss in our incoming physics majors is: we get a large fraction of our majors from a handful of high schools. And, those handful of high schools have really good high school physics teachers. And so, it’s like, if you’re a kid that happens to go to one of those schools—kind of like I did—then the answer is: yeah, I think those kids are maybe very well-prepared. But, I also know there are a lot of schools where physics isn't really even normally taught. The vast majority, I think—I saw some statistics a few years ago—the vast majority of schools in Mississippi don't have a licensed physics teacher. Usually, it's someone who's from another field. [...] So, I think that overall, probably the broadest answer—I don't know how we compare nationwide—but I think in a lot of high schools, it's hard to get a good preparation. It may be hard to get a good preparation in physics. There are certainly schools that do a good job, though. So, I think it's…it's probably entirely dependent upon where you go to high school. [...] In my opinion, this is probably a case by case basis, depending on the school. And, I think…I'm not sure that nationwide, that's not the same answer. We may have some more challenges in Mississippi than…than some states with more resources. But again, I think it—[in] my opinion, it very much comes down to the individual teachers, the people that are in that high school and the preparation they provide. I just can't overstate the value, I think, of a good high school experience in preparing kids for…for a career, like in physics.

Professor #17: I don't know that I'm in the position to gauge about Mississippi students in general, now. I've been away from that arena for a long time; except that I do have a son who's a freshman at [a Mississippi university] this fall, who took AP physics this last semester at [a high school in Mississippi]. [...] And, my thoughts are that they do well for the people who are capable students and the like; but, there is only one physics teacher, and so being able to serve in other capacities is tough for him. He does it. He's a good man. And, I think their program here is good for the good students. I have somewhat of a reserved opinion about what schools in Mississippi, in general, do for the average person that comes through school. […] And so, I can't really speak to everybody, but certainly the students from [the high school previously mentioned] go on and seem to do well everywhere. But, I suspect it's the way that it always has been. And that is, they have so few physics teachers that they don't get many takers in the high schools. It's kind of tough to have somebody imagine they could be interested in physics until they get in and start doing it. But, you have to do it. You can't talk to them about physics; you have to let them do all the things you do. And, physicists understand that. But, they just don't have the equipment, money, time, teachers, to do that sort of thing. So, it's…it's just sort of where we are, it seems to me.

Main Answers from Interviews with 5 Successful Mississippi-Native Physicists (Question #4):

(4) Do economic factors play a large part in students choosing to pursue (or not to pursue) graduate studies in physics?

Professor #13: I don't think so. Umm, I mean, my first guess would be: no. I think most physicists probably came from poor backgrounds, or…a lot of them are farm kids. And so…I don't see any economic connection.

Professor #14: I think so. You know, physics—at least at present—is a well-supported field. And so, if you go into graduate studies in physics, you'll get a good assistantship—at least, a living wage. And, so I think that this does attract more people into physics. The engineering school here—the assistantships are only about a third of what they are in physics […]. It's also reasonably…you're reasonably assured of getting a job […] your likelihood of getting a job is pretty good because there aren't many majors. Not as good as engineering, those people are actively pursued for jobs and get larger salaries at the start. But, I think those two things are encouraging for attracting people into physics.

Professor #15: I think they do, because…with the same amount of work and the same amount of talent, in my opinion, students can go into engineering, for example, and some other areas as well. And, for the same effort, they can come out with jobs that pay a lot better. And, the number of jobs for physicists, I think, in recent years has not been all that great. That's…of course, I've been out of teaching for [many] years, and kind of lost track of some of it. But, uh, that's my opinion…that the job market is not as good for them, and they—for that reason—choose other fields, for example.

Professor #16: I mean, this is only, obviously, my opinion, I don't have any statistics or facts to back [it up]—I suspect it does play some role. I think there's probably a strong…and again, this is just my opinion, just from walking around life…is that there's probably a pretty strong association between the economic background of a student and the educational background of that student's family. I suspect there's…there are some correlations there. They're not one to one; you can't guarantee that a student from a wealthy background comes from a highly educated background. You can't guarantee that a student from kind of an economically disadvantaged background—that their family doesn't have a good educational [background]. But, there's probably a correlation there, you know. […] I think the economic impact may be that students, maybe, who are first-generation college students—you know, I don't know if they're more or less likely to choose a field that's maybe a little less popular, a little less well known, like physics. I don't know. If you're first-generation college student, do you tend to migrate more toward better known fields where there are a lot more students going into those fields? I don't know. I don't know how that works. But, I mean, physics is a bit of an esoteric…subject in the sense that…there's, I mean, there's very few schools in the nation where anybody would say, "Boy, we had a lot of physics majors!" […] And again, it may go back to the fact that if you have an economically disadvantaged student, who went through an economically disadvantaged high school that didn't have a strong physics teacher, then, yeah, there may be a correlation there…um, that gets set up. […] They may not have had the educational opportunities along the way that would encourage a student to pursue something a little bit more of a—and "esoteric" is not the right word, but that's all I can come up with at the moment—uh, that type of discipline.

Professor #17: It was my principle reason for accepting the Atomic Energy Commission Scholarship way back in 1954. I mean, I had to have something, and I was working at the highway department as a—they called me a "topographical engineer"…I drew maps. And, I knew I didn't want to do that at the pay that they had. And this [Radiological Physics] really sounded of interest, so that's where I went. Economics always plays a factor, because with this a capitalist country, people feel like they're not doing well if they don't make a pretty good salary. […] They paid me more in that fellowship, than I made working a full forty-hour week at the Mississippi State Highway Department.

Main Answers from Interviews with 5 Successful Mississippi-Native Physicists (Question #5):

(5) What were the key factors, in your opinion, to your success in physics?

Professor #13: Well, I always worked hard was one thing. But I, you know, I wouldn't consider myself successful as a physicist. I was successful as a physics teacher, I think. But physics is a very humbling field. And, there are so many levels of ability. I mean, I had a high enough level to be a university teacher. But, I've never had any great research accomplishment. And even the people that have strong research résumés are a great level below the really star physicists. And even those people are way below the people whose names go down in history.

Professor #14: I have to give credit to my high school math teacher. [She] taught advanced math class. And, that really gave me the background to deal with the mathematics; and [it] made my math classes easier in college that she covered a lot of the college curriculum. So that's a big factor. And then […] there were things I got through with my undergraduate degree, and sort of my graduate degree, and…at Ole Miss at the time, the work load wasn't too onerous that we taught—I think, two laboratories—and so, you sort of say, "I've got all this time, I'm going to learn physics very well." And so, […] I had the time to really study and learn physics and not just try to get a grade in the class. And so, those two things, I'd say, would be the key factors.

Professor #15: Well, one was: I grew up on the farm, and I didn't want to spend my time plowing a mule, you know, and cutting firewood, and stuff like that. I was highly motivated to go to college and get an education, you know, and get a job that required an education—that was one of the things. And, I was used to working hard. I expected to work hard. And, I did work hard. I mean, I'm not the smartest person in the world, but I work about as hard as most of them do. And, I think that was part of my success. And then, of course, I had some good teachers along the way. And, you know, we had the assistantships. That helped out. I couldn't have done it. Another thing: I had several friends, you know, who got married and had to drop out, or they had to get a divorce because, you know, if you don't have any money…[and] you get married, you're liable to have all kind of financial troubles. So, for that reason, I just told myself I was going to wait. And so, that's part of it. I just stayed away from women, mostly. I didn't want to be side-tracked. That's one thing. And, then I had some good mentors.

Professor #16: I mean, there's obviously any individual student's personal drive to do something. And, so that was part of it. I had to drive to go get a PhD. I always wanted to be a college professor. Once I kind of got into physics, I really thought, "I want to be a physics professor. Really what I want to do." And so, I kind of did the things that I had to do to get to that point. However, the real key factors in my success were probably, honestly, being fortunate enough to hit the right people at the right time in my life; to encounter good math teachers and good physics teachers in high school (or a good physics teacher in high school); to encounter good math and good physics teachers in college as an undergraduate; for them to encourage me that I had the capability to do this.

[. . .] I was fortunate enough that everywhere along the way, I had other people who helped me be successful. And so, I would say that's the key factor, more than my personal abilities. It was kind of being fortunate enough to be in the right place at the right time.

Professor #17: Well [*chuckling*], all of my colleagues would argue [about] what success I've had in physics. But, mine is versatility. I got my PhD doing low energy nuclear physics. I went to work in industry at Sperry Microwave, a division of Sperry-Rand Corporation. And, I did work in cryogenics with superconductors. Prior to that, I had never had a course in solid state physics at Vanderbilt. At Sperry, I started work in ferroelectrics in solid state physics. I have chased storms while making lightning measurements […]. All of interest. But, it has to do with me as a peculiar person. I am not the typical physicist. I am a holistic thinker. […] I ask lots of questions. But, most physicists wonder why I asked that question. So…I'm just peculiar, and I understand that.

Main Answers from Interviews with 5 Successful Mississippi-Native Physicists (Question #6):

(6) What could be done to make the Mississippi education system better for producing physics students who will be in a position to have a successful career in physics?

Professor #13: Well, I don't know how to do it, but I've always felt the key was having strong mathematics in the high schools. I always felt like I could teach somebody the physics if they could do the math. But, so many Mississippi students are so poorly prepared in math. Even if they made straight A's in high school, they still can't do fairly simple stuff…because, the standards are so low. So, one thing is: the math level needs to be greatly improved, and to…to jump on your field, the math education departments…are…well, they just have very low standards. They don't produce mathematicians, and they…they produce people who use fad methods…and don't really, necessarily—the teachers, themselves, don't have a real good understanding of the subject. That's my impression.

Professor #14: I think—well, reaching back to my own high school years—I think the really important thing is that math class, and the fact that there was a two-level math class [at my high school] where there was a…there were about thirty (out of a hundred and twenty people in my class) in the advanced class. And…so, we did a lot more than we would have otherwise. And, so, I think that maybe having advanced classes in math […] would really help. I don't think the physics background is so important as much as the math background.

Professor #15: Well…one thing they need to do is: make the high schools do a better job of preparing people in mathematics and science. That would be one thing. That's essential. They've got to do a better job. And the other thing—if you want to attract people—one way to do it, you know, is to have some kind of economic incentive. Have some scholarships that these people can get. Without those fellowships, brought on by our competition with the Russians, I might not have made it. And so, that's another thing. And then…having jobs that these people can get once they get the degree. Those are the three things I can think of off the top of my head.

Professor #16: I think this is a question that addresses Mississippi…[it] goes nationwide, really […] I don't know that I really understand what it is that I can quantify what makes a good, encouraging teacher versus one that's not. It's kind of like one of those things, "you know it when you see it." So, I have a hard time quantifying exactly what could be done. But, I think, in large measure, we have to invest in our high school math and physics teachers. And really, high school is probably too late. It goes all the way back. You've got to get, you know, the educational system starting when kids are young…trying to engage them in not just memorizing facts and figures, but […] it just seems to me that it's a matter of not teaching them to take a test, necessarily, or teaching to a test ("we have to pass this test, memorize these things"). It's much more about kind of, you know, bringing in activities and things that they can be a part of. […] I honestly don't know, other than: we have to make it a priority…for good teachers. […] I think, by and large, we do not reward our elementary and high school teachers the way we should. We don't necessarily always take into account the dramatic impact that they have on people's lives. […] It certainly is true in Mississippi, but I think it's true everywhere…that we as a culture have to value that, and put our money where our mouth is, and be sure that we pay teachers adequately enough we get people in the classroom who want to be there. […] It's not about, "Hey, let's get laptops on every desk." OK, maybe that's useful, maybe that has some value. I mean, I'm not saying that's a bad thing. I'm just saying that giving kids a bunch of laptops in a room, without a solid teacher to work with them, is not going to generate success. […] It's not a technology answer, I don't think…I don't think the answer is, um…it's not just financial, it's not just technology, it's about people; and people inspiring kids to want to do these things. And, I was fortunate enough to have that. And, that's why I was successful, I think. And, I don't know how you replicate that…everywhere. But, I mean, that's fundamentally, I think, what has to happen.

Professor #17: Don't know the answer. I think we do a pretty good job. If you want to be a physics major and go on and get a PhD in physics, Oxford's school system does a good job. OK. Some students come over here [to the Ole Miss campus] and take university courses; mathematics, whatever. So, the opportunity is there, here. It's probably available at State [Mississippi State University] and Southern [University of Southern Mississippi]. […] I think good students are hard to hold back. […] If they know what they want to do, and you give them a way to get there, they get there.

Commonly Mentioned Themes from the Main Answers of the 5 Successful Mississippi-Native Physicists who were Interviewed

Table 371

Commonly Mentioned Themes from the Interviews with the 5 Mississippi-Native Physics Professors

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1. Why did you choose to pursue a career in physics?

**I had a great high school physics teacher. (3)

**I enjoyed the subject of physics. (3)

*I had a good high school science and math background. (1)

*In my high school physics course, the teacher handed out some brochures which showed people working with lasers and advanced aerospace things, and that increased my interest in a physics career. (1)

*I'd always been interested in things. (1)

*I thought it would be a challenge. (1)

*My father was a geophysicist, and so he was always interested in sciences and teaching us about science. (1)

*Physics chose me due to the offer of a nice fellowship. (1)

*No Clear Reason (1)

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2. What obstacles did you have to overcome during your years as a student and during your years as a physicist?

*I had a discouraging experience with a certain professor’s class. (1)

*I was the first person in the family to attend college. (1)

*I had to quit work so the studies could be properly attended to. (1)

*The financial burden of attending college upon my family was an obstacle. (1)

*The financial burden experienced during the time of being a graduate student was an obstacle. (1)

*The decision of where to go to graduate school was an obstacle. (1)

*When I initially entered graduate school, I had somewhat of a lack of confidence about my ability to do the academic work; this was due to the fact that I somewhat believed some of the negative things you hear in the media about Mississippi academics. (1)

*I had to fix or repair a faulty piece of electronics equipment which was necessary for certain measurements. (1)

*I do not think I had any obstacles. (1)

3. Do you think that Mississippi students are as well-prepared, as other students, for the academic rigors of physics?

**It varies greatly from school to school; there are some great schools and some very poor schools. (3)

*We probably have more weak schools than most states. (1)

*I think it depends almost entirely on where the student went to high school and the physics teacher who was there; I just cannot overstate the value of a good high school experience in preparing kids for a career like physics. (1)

*I suspect that it is the way that it has always been in that there are very few physics teachers which means that there are few students who take physics in high schools; and it is hard to get students interested in physics unless they can get in and start doing it; you cannot just talk to them about physics, you have to let them do all the things you do; and physicists understand that, but they just do not have the equipment, money, time, or teachers to do that sort of thing.(1)

*It’s something it would be nice to see the state improve. (1)

*I do not think they are as well-prepared as they should be. (1)

*I do not have enough experience with teaching students from other places in order to say for certain whether or not Mississippi students are as well-prepared as the average student from other places around the country. (1)

*I do not know that I am in the position to gauge about Mississippi students in general, now; I have been away from that arena for a long time; however, I do know that one local school has a good physics program for the good students, but I have somewhat of a reserved opinion about what schools in Mississippi, in general, do for the average person that comes through school. (1)

4. Do economic factors play a large part in students choosing to pursue (or not to pursue) graduate studies in physics?

**Yes. (3)

**No. (1)

**I suspect they play some role. (1)

*I think so due to the fact that physics, presently, is a well-supported field, and so if you go into graduate studies in physics, you will get a good assistantship; and so, I think that this does attract more people into physics; physics assistantships [at the University of Mississippi] pay graduate students much more than the assistantships offered by the engineering school [at the University of Mississippi]. (1)

*I think so because they are reasonably assured of getting a job since there are not many physics majors. (1)

*I think they do because for the same amount of work and talent, students can go into other fields, such as engineering, and come out with higher paying jobs. (1)

*I think they do because the number of jobs for physicists, in recent years, has not been all that great. (1)

*Economics always plays a factor because with this being a capitalist country, people feel like they are not doing well if they do not make a pretty good salary. (1)

*It was my principle reason for accepting the Atomic Energy Commission Scholarship; they paid me more in that fellowship than I was making working a full 40-hour week at my previous job. (1)

*I suspect that there is probably a pretty strong association between the economic background of a student and the educational background of the student's family, with the economically advantaged backgrounds probably being correlated with the more highly educated backgrounds. (1)

*I suspect that economically disadvantaged students who attended economically disadvantaged high schools which did not have a strong physics teacher might not have had the educational opportunities along the way that would encourage them to pursue an esoteric subject like physics. (1)

*I don't think so; most physicists probably came from poor backgrounds; many of them are farm kids. (1)

5. What were the key factors, in your opinion, to your success in physics?

**I had a good teacher or good teachers along the way. (3)

**I worked hard. (2)

*My high school math teacher taught advanced math class and covered much of the college curriculum; and that helped me develop a good math background for my college math classes. (1)

*I was fortunate enough to encounter the right people at the right time, such as good math and physics teachers in high school and college; everywhere along the way, I had other people who helped me be successful. (1)

*I had some good mentors. (1)

*While I was an undergraduate and graduate student, I had the time to really study and learn physics and not just try to get a grade in the class. (1)

*I had the personal drive to get a PhD, and did the things necessary to become a physics professor. (1)

*I grew up on a farm doing very hard physical labor, and I did not want to keep doing that; thus, I was highly motivated to go to college so I could get a job that required an education. (1)

*Being able to have an assistantship helped out. (1)

*I had several friends who got married and had to drop out; some had marital problems; if you get married and you do not have any money, you are liable to have all kind of financial troubles; so, for that reason, I just told myself I was going to wait; I did not want to be side-tracked. (1)

*I was able to be versatile; I have worked in a wide variety of different fields. (1)

*I am not the typical physicist, I am a holistic thinker; I ask many questions. (1)

*I would not necessarily consider myself to have been a successful physicist, but I was successful as a physics teacher. (1)

6. What could be done to make the Mississippi education system better for producing physics students who will be in a position to have a successful career in physics?

**Students need better math preparation in the high schools. (3)

**Although I have some ideas about it, I do not fully know the answer; I do not fully know how to do it. (3)

*The math education departments need to have higher standards so that mathematicians who understand the subject can be produced rather than people who use fad methods. (1)

*Having advanced math classes in high school would help. (1)

*Better science preparation in the high schools would be beneficial. (1)

*We must also engage young students before they get into high school so that they do more than just memorize facts and figures; we must do less of teaching students to take a test and teaching them to memorize things, and we must do more of bringing in activities that they can be a part of. (1)

*It’s not really a technology answer, such as giving the entire classroom laptops, but it is more about having solid teachers who can inspire kids to want to do these things. (1)

*We have to invest in our high school math and physics teachers. (1)

*We have to be sure that we financially reward our elementary and high school teachers adequately. (1)

*It would be beneficial to have some economic incentives, such as scholarships or fellowships for students. (1)

*It would be beneficial to have jobs that the students can get once they get the degree. (1)

*I think we do a pretty good job, especially at certain schools and locations in the state, such as near some of the major universities; so there are opportunities for students; I think good students are hard to hold back; if they know what they want to do, and you give them a way to get there, they get there. (1)

Note. Five native Mississippi professors were interviewed for the above table. They were either born in Mississippi or (in one case) moved to Mississippi as an infant. Using the text from the "Main Answers" which the he selected from the interviews, the researcher (P. Rogers) further selected and tried to summarize the themes/main answers given by the professors. Then, in parentheses beside each respective theme/main answer, the researcher put the number of times each theme/main answer was given as an answer by a professor in the group. Some professors gave more than one theme/main answer; in other words, they may have had a list of answers or several parts to their answer; in that case, each different part of their answer represented a "theme/main answer." Thus, there are more than just "5" total tally marks for each interview question, because some professors gave several parts to their answer. Also, in some cases, a certain part of a professor's answer applied to more than just one theme/main answer. Usually, this occurred when the answer fit a broad general theme/main answer, but also fit a more specific theme/main answer. For example, suppose a professor was being asked why he chose a career in physics. And, suppose the professor gave the following answer: *"I had an outstanding physics teacher in high school who involved us in interesting experiments which fascinated me, and that was the beginning of my interest in physics as a subject and as a career."* That answer would fit a specific theme/main answer such as, *"My high school physics teacher involved our class in interesting experiments."* But, it would also fit a broader theme/main answer such as, *"I had an excellent high school teacher."* Thus, both themes/main answers would get a tally mark if the professor's answer applied to both of them. Hence, in cases where the professor's answer fit more than one theme/main answer, the researcher (P. Rogers) gave a tally mark to every theme/main answer which was applicable to the professor's answer. This way, the number of tally marks (shown beside each theme/main answer as a number in parentheses) will show us which themes/main answers were most commonly given by the professors; and, at the same time, we will not lose the important information given by the professors in the more specific themes/main answers.

VITA

Educational Information

- Graduated from Taylorsville High School in Taylorsville, MS (Spring 1994)
- Attended Jones County Junior College and took Pre-Engineering courses (Fall 1994-Spring 1996)
- Mississippi State University (Bachelor of Science in Chemistry/Physics Education in May 1999)
- University of Mississippi (Master of Arts in Physics in December 2003)
- Attended University of Southern Mississippi and took a Latin course and some computer/web design courses (Aug. 2008-May 2009)
- Enrolled in graduate school at the University of Mississippi; took graduate-level classes in physics (Fall 2009-Spring 2010); took graduate-level classes in secondary education (with science emphasis) (Summer 2010-Spring 2012); continued dissertation work in secondary education (Summer 2012-Present)

Relevant Work Experience

- High School Teacher (chemistry and physical science) at Charleston High School in Charleston, MS (Aug. 1999-May 2000).

- Physics Teaching Assistant at the University of Mississippi (Aug. 2000-Dec. 2003)
- Physics Instructor at Meridian Community College (Jan. 2004-June 2008)
- Self-Employed (math/physics tutor in Hattiesburg, MS) (Fall 2008-Summer 2009)
- Physics Teaching Assistant at the University of Mississippi (Aug. 2009-May 2012)
- Adjunct Physical Science Instructor at Northwest Community College (Oxford Branch) in Oxford, MS (Fall 2011-Spring 2012)
- Physics Instructor at Meridian Community College (Aug. 2012-Present)

Some Professional Interests

- Fractals and self-similarity, and how this topic relates to science and physics
- History, including the history of education
- Economics, including the relationship between economics, science, education, and other areas of society